Students' Experiences Of Studying Undergraduate Mathematics An Investigation Of Approach, Support And Identity

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Abstract

This thesis explores one group of undergraduate mathematics students' experiences throughout their three year degree course, to gain a better understanding of why some students' attitudes to mathematics change during this period.

Research by the "Students Experiences of Undergraduate Mathematics" (SEUM) project (Wiliam, 2005) explored some of the factors influencing undergraduates. This study extends that work by investigating the experiences of another cohort, looking specifically at their approaches to learning, conceptions of mathematics, the support they encountered during their degree, and how these impacted on their attitudes. These themes were investigated throughout the students' degree course, by taking a mixed methods approach to the research design.

Questionnaire data was used to compare the cohorts' approaches to learning, and conceptions of, mathematics, at the beginning and end of their course, and to investigate whether these factors related to the students' examination marks. No statistically significant changes over the period were found, and contrary to previous research, no relationship was found between these factors and examination attainment. Four student case studies, combining both questionnaire and interview data, are presented to help explain these results, illustrating how contextual factors of the teaching and learning environment affected outcomes.

Analysis of interview data demonstrated that the type and degree of support experienced was an important influence on these students. Dividing the analysis between the social support from peers, and the academic support of peers and staff in their department, led to insights into ways students do, or do not, integrate into the university context. This work highlights the importance of the social aspects of being an undergraduate, and of academic support in developing the students' sense of belonging. This sense of belonging, or lack of, was a salient factor affecting their attitude towards mathematics. Implications of the findings for practice in undergraduate teaching are discussed.

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Chapter 1: Introduction

This study looks at the experiences of one group of undergraduate mathematics students in terms of their approaches to studying, and conceptions of, mathematics; the support they did or didn't encounter during their degree; and what impact this support had on their academic identity. I investigate these themes longitudinally, throughout their three years at university, by taking a mixed methods approach to my research design.

In this opening chapter I set out my rationale for embarking upon this thesis: why, and where, methodologically and theoretically, my research started, where I ended up, and how my approach developed over the period. In doing this I will set out the research questions that have shaped the study over its duration. I'll also describe my relationship with mathematics, my role within the University, and my involvement with the mathematics department in which the study took place. I then introduce the participants of the study. I end the chapter by giving an overview of the chapters to come and my reasons for structuring this thesis as I have.

Development of rationale

During the 1980s and 1990s many UK university mathematics departments felt that the gap between school and university level mathematics in England was widening and becoming even more apparent with the shift to a mass system of Higher Education (Bibby, 1985, Cox, 1994, London Mathematics Society, 1995). With students now coming from a much more diverse background, a change in many A-level syllabi and fewer students taking double mathematics at A-level, the difficulties in this transition were exacerbated further (Lawson, 1997, Kitchen, 1999, Sutherland and Dewhurst, 1999).

My experience during the 1990s of working with undergraduate students highlighted to me that a failure to understand what their lecturers considered to be basic mathematical concepts early in their degree course could quickly lead to a downward spiral in a student's confidence. This was true whether the student was studying mathematics at single, joint or combined honours level, or even just within

compulsory modules of some other science degree course. It was while working in the teaching and learning unit of one Russell Group University, and in particular with students in the Mathematics Department, both as the Peer Assisted Learning (PAL) Coordinator, and then later as a research fellow on two small scale research projects, that I felt I wanted to know more about the difficulties students face both with the transition into university mathematics, and student life in general.

I decided therefore to investigate some of the factors that influenced these students during their three year undergraduate degree programme. My hope was that a better understanding of this range of factors could then be taken into account by staff in the mathematics department involved, for the benefit of future students. At the time my study was started in 2000, previous research had looked at the changes that universities had made to their degree programmes in terms of the content (Kahn & Hoyles, 1997) or style of teaching (Berry & Sharp, 1999). Other researchers had focused on the motivation (Hall, 1982) of mathematics undergraduates just starting their degree, attitudes (Galbraith, 1984) of undergraduates and prospective teachers to mathematics, and conceptions of mathematics and how it is learned (Crawford et al, 1994). None of these studies had taken a longitudinal approach.

However, a three-year Economic and Social Research Council (ESRC) funded research project, namely “Students’ Experiences of Undergraduate Mathematics” (SEUM) was just starting at Kings College London and Leeds University (Brown & Macrae, 2003). The main aim of this study was to develop a better understanding of why students experience undergraduate mathematics programmes in different ways and why some maintain or develop more positive attitudes than others to the subject. This study followed two groups of single honours mathematics students through the UK standard three years of their degree programme. The five subsidiary aims of the SEUM project were:

i. to understand what experiences and knowledge contribute to building positive attitudes both to students' own competence and to mathematics as an academic discipline.
ii. to explore the ways in which undergraduate students feel they are helped and/or hindered in their learning of mathematics.

iii. to identify ways in which students can be encouraged to complete a mathematics degree rather than transferring, failing or withdrawing.
iv. to explore the reasons why students elect to study mathematics at university and why they select or reject a teaching career.
v. to understand more about the ways in which mathematics undergraduate students' attitudes to the subject change over the period of the study.

My study initially planned to run alongside the SEUM project and to share its aims, while providing another institutional context to complement the work being done. The cohort involved in my study however differed from those in the SEUM project, as it included many students who were studying joint and combined honours mathematics courses based within the mathematics department of this particular university. I decided to include these students, along side those studying single honours mathematics, to provide this additional context to my study.

Similarly to the SEUM project though, my research set out to investigate some of the factors that influence undergraduate mathematics students' performance, and attitudes to their subject, throughout their degree course at another large, inner city university. I planned to do this looking at prior experience of learning mathematics, approaches to studying and conceptions of mathematics, progress in terms of exam performance, confidence with mathematics, and how these change during the three year degree course.

Many of these factors do still feature in sections of this thesis, but as my study progressed, my focus shifted at various times as my conceptual goals changed. Not long into my work I also realised that the aims of the SEUM study, designed for a grant funded research project, were not entirely appropriate or achievable within the scope of a PhD study. A month or so into my data collection I decided not to investigate why students decide to study mathematics, or their future teaching aspirations. As my data collection continued I also decided not to investigate in any depth why students transfer, fail or withdraw from their mathematics courses, even though approximately a third of the original cohort did not progress into their second year in the usual way. By the third, and final, year of data collection my primary concern was to gather questionnaire and interview data on the longitudinal aspects of

the students' approaches to, and conceptions of, mathematics, and to gain further insights and reflections on their experiences over the period of their degree course.

This longitudinal nature of the study, and my personal circumstances over the duration, also played important parts in how this thesis has evolved. As I'm sure most, if not all, PhD students would agree, the experience of studying for a PhD is a very personal one. There are many turning points along the journey, where decisions are made that can take the process on different paths. Many of these decisions are made through necessity and practicality as mentioned above, and some through personal interest. For example, during the period of working on this thesis I have had three children with associated periods of maternity leave. This has meant that I have had periods of not fully engaging with my data, both during the collection, and the analysis stages, but then revisiting my research anew. It also meant that the whole PhD process has taken longer than originally envisaged, and during this last decade there have obviously been changes in the research landscape.

All of this has influenced both the final structure of this thesis, and the different ways in which I have approached my data. In particular, what the interviewed students expressed as being important to them at particular times during three years of studying played a large part in shaping two of my research chapters. They placed as much emphasis on the social aspects of their university experience, as they did on the academic, and the foci of support and identity emerged from my data analysis of their interviews. My decision to investigate this further was also influenced by recent research literature e.g. Solomon (2007) and Black et al (2009).

With this change of focus from my original research proposal moving me away from the main, and subsidiary aims of the SEUM project, my research question also changed to become,

How do mathematics undergraduates' experiences and attitudes change during their course?

Research Chapters 4 and 7 address this, specifically in terms of mathematics as the subject of study, and this particular department as a learning environment. Chapter 6

however investigates these students' transition into university life more generally, while still providing relevant insights. The three research chapters also have subsidiary aims and therefore address the following questions respectively, each specific to their focus:

- **Chapter 4: How do these students' approaches to studying, and conceptions of, mathematics, relate to each other; change over time; and do they relate to the students' examination results?**

- **Chapter 6: How does social support during their time at university impact on these students?**

- **Chapter 7: How does academic support impact on these students' attitudes to mathematics?**

My background, and role in the university

As a child I loved mathematics at both primary and secondary school. I loved getting the correct answers, I was fast at mental arithmetic, I loved that I was in the top set, and that for the most part I had no difficulty understanding any new concepts that were introduced. I sat my "O" level maths a year early and achieved a grade A. A year later I sat my "AO" level and also achieved a grade A. I decided to take both Mathematics and Further Mathematics at "A" level, taking the first exam after one year, and the next the year later. I achieved a grade B in Mathematics and then, disappointingly at the time, a grade D in Further Mathematics.

This last exam result initially dashed my hopes of going to my top choice university to study mathematics. However, I discovered that my overall grade had been brought down considerably by a low mark on the applied mathematics paper, and that I had achieved a high mark on the pure mathematics paper. After a discussion with the admissions tutor for the mathematics department, it was confirmed that I would still be offered a place. I accepted it gratefully!

Looking back, I realise now that this was a huge turning point in my relationship with mathematics. I started my degree course with high hopes, but very soon found myself struggling with the work. I had never had to ask for much help before, or work particularly hard, and was in amongst a group of peers who, despite their protestations, appeared to me to be struggling much less than I was. I'd also gone from studying A level Further Mathematics at school in a group of eight peers, to being at university in a lecture theatre of up to 60 other students at a time.

Finding myself no longer able to rely on understanding everything first time without much effort on my part, I began to slip further and further behind. I was however really enjoying life as a student. Meeting new people, living away from home and enjoying my independence all contributed to my determination to struggle on. Despite failing various exams along the way I did complete my degree within the three designated years, and achieved a pass. I had scraped through. By this stage I no longer felt I enjoyed mathematics, and wanted to do something completely different.

I was lucky enough to be able to enrol on another degree course at a different university, this time in Photographic and Electronic Image Science, and having successfully completed the three years was asked if I would consider teaching the compulsory mathematics modules on this course. The students taking this degree had a huge range in their prior experience of mathematics as a subject, from high grades at A level, through to failing GCSE, but helping those that struggled the most brought my enjoyment of mathematics back to life.

A few more twists and turns in my working life, and I ended up employed in the Higher Education Research and Development Unit, back at the university where I had originally studied mathematics, and at which this research study took place. I became involved in a programme called Peer Assisted Learning (PAL), and over a period of a few years I took on the role of lead PAL coordinator in the university, responsible for organising, and running the training for the programme in various departments across the university, including the mathematics department.

PAL is a student-to-student support scheme for both academic and personal development. Volunteer students who have just completed a conceptually difficult

course are trained to facilitate the learning of students on the same course in the following year. These trained students, called 'PAL Leaders', meet regularly with small groups of students in the year below to help them improve their understanding of the subject matter of their course and develop their study and learning strategies. When PAL is run on first year courses, it can also help the students attending to integrate into their department during the first few difficult months of being at university.

The character of PAL sessions is one of cooperative and collaborative learning. They are usually timetabled weekly into the curriculum, and centre round an hour of discussion and interaction. It is made explicit from the start that the PAL Leaders are not there to teach, and the students attending should not expect them to. They are there to encourage discussion amongst the group, and to enhance comprehension of lectures already attended, not to impart any new knowledge.

During this time I also became more and more interested in research in education, and was keen to further my career and be taken seriously in this highly academic establishment. I was encouraged by colleagues, and my head of department, to enrol on an MA in Mathematics Education at Kings College London. I chose to undertake a double-module dissertation entitled “Students’ conceptions of, and approaches to, studying mathematics as a service subject at undergraduate level”, in which I investigated whether students’ approach to studying their honours degree subject differed from how they approach, or have in the past approached, their studying of mathematics. I thoroughly enjoyed the MA programme, completed it in less than two years, and immediately enrolled as an MPhil / PhD student.

By this time I had also become a research fellow within the Higher Education Research and Development Unit in which I was working, and enjoyed applying for, and participating in, small-scale research projects on different aspects of mathematics education with undergraduate students. Two of these grant funded projects took place in the same department as, and were concurrent to, my PhD study, although all three pieces of research were investigating very different themes.

In 2001 I was awarded an LTSN Mathematics, Statistics and Operational Research Network grant for a project entitled “Groupwork reluctance in mathematics education” which investigated the use of groupwork with undergraduates at three UK universities. The first year cohort at each university was administered questionnaires, and a small subgroup of students interviewed, to elicit information about their experiences and attitudes towards groupwork in mathematics. Lecturers were also interviewed about their experiences of using groupwork with their students. The main aim of the project was to produce a set of guidelines for introducing groupwork with mathematics undergraduates (MacBean et al (2001) and also found at http://mathstore.ac.uk/headocs/GuidelinesForGroupwork.pdf, retrieved June 2011) but a research paper, MacBean et al (2004), was also written which focussed on the students' experiences of group work in mathematics, at both school and university, and their attitudes towards it.

After two unsuccessful large scale bids to both ESRC and Leverhulme, in 2003 I was awarded a Social Sciences Small Grant from the Nuffield Foundation as a joint applicant in conjunction with a colleague from the Mathematics department in which my PhD study took place. The title of this study was “Closing the Gap in School-University Mathematics: Towards Epistemological Cohesion”. It was a pilot study that aimed to develop and investigate the effectiveness of ‘catalytic problems’ (CPs), pivotal problems that aimed to catalyse the progression towards undergraduate mathematics. The problems involved in their solution, an appreciation of the similarities and differences between the knowledge required for the A-level and university curricula. They required connections to be made between different viewpoints, uses and representations of mathematical ideas. These CPs were trialled with sixth form students under a mentoring programme with university lecturers.

My relationship with the mathematics department in which this study took place was therefore two-fold: I studied there as an undergraduate, and many years later I worked in collaboration with staff within the department, both on small scale research projects and the PAL programme. When I approached the department in terms of the research for this thesis they were very happy to give me access to the year group of students I followed, and individual members of staff even allowed me into their lectures on occasion to administer questionnaires.

As a researcher I was very aware that my experience of studying mathematics in this same department would influence my study. However, I also knew that this could be used to my advantage. I knew the structure of the department in terms of its teaching and learning strategy, and I had a working relationship with some of the members of staff, which enabled me to have access to information such as examination marks, while still adhering to all data protection issues. I acknowledge here therefore the ethical issues that arise from having these prior relationships, but will address them properly in chapter 2, alongside others concerning my research design.

Participants

Having introduced myself in terms of my background, my role within this university, and potential influence on this study, here seems a sensible place to introduce the participants in this study too. I hope this will start to give the reader a sense of the degree courses available in the department at the time that the study took place, the particular year group of students whose progress I followed for three years, and the small subgroup of students who agreed to be interviewed during their three years of studying.

The cohort

At the start of this study the department had an intake of approximately 140 students per year. The department very kindly allowed me access to the 2001/02 intake of students on a regular basis, in order that I could administer the questionnaires, have access to examination results and progression information, and contact them en masse via email. Some of the background information about the cohort is shown in Table 1.1. The total number of students on the original departmental list that year was 142, and my initial questionnaire (Questionnaire A which can be found in Appendix I) elicited this basic information. 124 students fully or partially completed the questionnaire, i.e. an 87% completion rate. Although, as later discovered, some of these 142 students on the original departmental list never enrolled in the department.

Descriptive	Percentages
Questionnaires completed (N= 124)	97% fully, 3% partially
Gender	68% male, 32% female
Age	92% under 20, 8% over 20
Fee status	80% EU, 20% overseas
Gap year	19% took a gap year, 81% did not
This university as first choice	76% yes, 24% no (mostly after Cambridge)
Financial worries	28% a lot, 58% some, 14% none
Expected to work p/t	44% yes, 33% not sure, 23% no
Accommodation	65% halls etc, 20% with parents, 7% renting, 6% unknown at time, 2% own home

Table 1.1: Summary of some of the basic findings from Questionnaire A

The Interview Participants

In total I interviewed twelve students during this study, and the majority of them were self selecting, in that they replied to requests, either via Questionnaire A or a follow up email, for willing participants. I chose this method of selection in the hope that if a student freely put themselves forward, they would be more likely to participate long term.

Eight of these twelve students met with me on a regular basis and were interviewed throughout their degree, a maximum of seven times each. Background information on these eight students, gathered from Questionnaire A and their first interview, is presented in Table 1.2. The other four students who participated were interviewed just once each. Two of these students attended the first round of interviews and were not interviewed again, one because she changed degree course, the other because he no longer wished to take part in the study. Neither of these interviews were subsequently used within this study. The other two (Charlotte and Adam) were approached in Year 3 of the study and were also interviewed just once, as will be explained later in this section. Some of their background information has been included in Table 1.2, but not all details were obtained during this one interview.

	School attended	Prior Maths exams	Mother's occupation	Father's occupation	Gap year	Course	Term time accommodation	University clubs
James	High school / technology college	A level – A Further – A	Housewife	Management consultant	Yes – enforced	Maths with a European language	Intercollegiate hall of residence	Debating society and conservative society
Lyn	Mixed state comprehensive then sixth form college	A level – A Further – A Step II – U	Mum: Housewife Step-mum: Shop worker	Dad: Mechanic- Step-dad: Site manager	Yes- worked and then travelled	Maths – dropped management	Hall of residence	Drama and dance
Hakim	European school in Brussels	International Baccalaureate	Secretary	Rents out flats	No	Maths – dropped Comp Science	Hall of residence	Chess club
Rafik	State boys school then sixth form college	A level – A	Infant school teacher	Recruitment officer for council	No	Maths and Physics	Home with parents	Islamic society
Sarah	All girls grammar school	A level – A	Housewife	Shop worker	No	Maths and Physics	Hall of residence	None
Yen	Mixed state comprehensive	A level – A Further – B	Doctor	Microbiologist	No	Maths and Physics	Hall of residence	None
Steve	Private	A level – A Further – A	Aromatherapist	Computer programmer	No	Maths and Physics	Home with parents	None
Jane	Private girls school, then private mixed school for A levels	A level – A Further – A Special paper – distinction Step II – 3 Step III - 2	P/t book keeping	Accountant	Year at another university	Maths and Astronomy	Hall of residence	Photography society
Charlotte	Mixed state comprehensive	A level + Further – grades unknown	-	Doctor	No	Maths	Hall of residence	None
Adam	Mixed state comprehensive	-	-	-	Had started a Biochemistry degree	Maths	Renting a flat	None

Table 1.2: Summary of background information about the eight main interviewees – all names have been changed here, and throughout the rest of this thesis

My original plan was to interview at least one student from each of the seven possible joint, or combined, honours degree pathways being offered by the mathematics department that academic year, namely: mathematics and, physics, astronomy, or statistical science, all joint honours courses, and mathematics with a European language, computer science, management studies, economics, all combined honours degrees. The decision was meant to provide my study with a slightly different context to that of the SEUM research project, but still allowing for a comparison of data between the two studies. However, although my initial self-selection method of gathering interviewees managed to gather eight students, between them they were studying only five of the seven possible pathways. I therefore decided to target students enrolled on the two unrepresented pathways to see if I could persuade one from each to participate in the study. I did this by approaching students direct during one of my visits to the mathematics department early in the study. By striking up a conversation about the project, and asking which pathway the student was enrolled on I managed to find two more willing participants from the two missing pathways.

As it turned out two of the main eight interviewees dropped the other subject area they were studying during Year 1, as can be seen from Table 1.2, and moved on to the single honours mathematics degree programme. Also, the two students who I interviewed just once during Year 3, were enrolled on the single honours mathematics degree programme. However, as my study progressed the issue of which course the students were enrolled on seem less important than following the experiences of these eight students who had been interviewed from the start of their course.

In retrospect, a disadvantage of the majority of these eight main interviewees being self-selecting was that they all attained either a first or upper second class honours in their final degree results, and so could not be considered as representative sample of the whole year group. On the other hand, the big advantage of having a self-selected group was that contact continued throughout the three years, as they were keen to participate in the research. This also enabled me to build up more of a relationship with the interviewees, and develop a rapport, which I felt helped put them more at ease, especially in the latter interviews when they were reflecting on their time at

university. This helped me enormously in terms of the longitudinal aspect of this study and being able to compare their reflections with what they told me at the time.

However, once the students' second year examination results were made available to me, and it became obvious that these eight students were all likely to achieve a good degree result academically, an effort was made to interview other students who were struggling more in terms of their examination results. A sub-group of the cohort who appeared all on course to achieve a third class honours degree, or less, were sent an email with details of the project and a request for further participants. Two students replied, Charlotte and Adam, and were willing to be interviewed, so were added to my interviewees in the third year only. As will be seen in Chapter 4 these two students enable me to make an interesting comparison that otherwise would not have come to light.

An outline of the thesis

As already discussed, my journey in writing this thesis has been a long one, and I have taken several periods away from the data during the process. I therefore have chosen to present the chapters of this thesis in a particular order that leads the reader through the study both in terms of my research questions, but also highlights how what the students focussed on in their interviews led me to a change in direction part way through.

Chapter 2 sets out my research design starting with an overview of my research approach, and the mixed methods used to collect my data. I then describe this data collection chronologically including detailed descriptions of the two main data collection methods used, questionnaires and interviews, and give an account of the ethical considerations of the study. I also describe issues that arose from data analysis methods that were tried and abandoned along the way, before closing the chapter with my conclusions.

This is followed by the first of two literature review chapters, Chapter 3, which starts by noting the historical explosion of, and trends within, research on student learning in higher education. I then look more specifically at research on undergraduate

mathematics education over the last two decades, and lead in to literature that specifically influenced the data analysis presented in the Chapter 4. The literature reviewed in Chapter 3 therefore helps me to explain where my thinking was when I started my study.

Chapter 4 is then the first of my data analysis chapters, and starts by returning to my main research question. The subsidiary research question that underpins this chapter is introduced and then subdivided into five specific focus points, each of which is dealt with separately. I answer the first four of these by presenting the quantitative data elicited from the questionnaires on students' approaches to, and conceptions of mathematics. This questionnaire was administered twice and I investigated any difference between the students' responses each time. I also looked for correlations between these scales, and between these scales and the students' examination results during their three years.

Some of my findings in this chapter differed from those in prior research papers (e.g. Crawford et al, 1998a) so to help answer the fifth of my focus points I investigated the questionnaire results of four particular students in more detail. Case studies of these same four students, drawing on qualitative interview data, also provide a way of helping me to explain my quantitative results in context. Links are also made to recent research that helps to corroborate my findings, and conclusions drawn.

The second literature review, Chapter 5, helps me to put my final two data analysis chapters in context, by highlighting that in some ways they have more in common with the generic research on undergraduate attrition and retention, than that on student learning. I also use the models inherent in attrition and retention research to provide structure to the two subsequent data analysis chapters, while acknowledging that previous research on social and academic integration in itself is insufficient to explain my data. I also therefore draw on recent research on students' sense of belonging, especially work by Solomon (2007) and Palmer (2009) and end this Chapter 5 by discussing the implications of this literature in terms of the data analysis that follows in Chapters 6 and 7.

I start Chapter 6 by setting out the theoretical frameworks that I draw upon to subsequently analyse my data. This analysis addresses how some students manage their transition to university life better than others, by drawing on both questionnaire and interview data to describe what the students voiced as being important in terms of their interactions with their peers on non-academic matters. By exploring these issues I highlight the different things students looked for in terms of social support and how they go about finding it, as well as the ways in which some students started to develop a sense of belonging, and find their place in the institution.

I do this by looking at three main locations, that emanate from the data, where the students describe their interactions with their peers, those being: the student's *accommodation*, the student's *department*, or departments in the case of those taking joint honours, and the *wider institution*, i.e. the rest of the university outside of the previous two categories. These three categories also provide a longitudinal dimension to the data as the students spoke most extensively, although not exclusively, about accommodation in their first year, and their department and wider institution more in their second and third years of their degree.

Chapter 7 is my final data analysis chapter, and draws primarily on interview data, but the focus moves from the more social interactions of the previous chapter, to what the students said about their interactions with both their peers and with staff, in terms of academic support. However, the overlap between these two chapters is acknowledged as being important. Many of the students referred to "friends" and "friendship" when they spoke about this support, and so I also draw on research about friendship, specifically in educational contexts, and look at how these students categorised both peers and staff in terms of the support they provided for them.

I use the theoretical lens of figured worlds (Holland et al, 1998) to investigate the students' experiences, this time looking specifically in terms of their relationships with each other, and with staff, in the context of their studies and their department. I also investigate the impact these relationships had on the students, in terms of the support they gained, or didn't, and how this changes over the period of their degree.

Finally, in Chapter 8 I draw together the main conclusions from my three data analysis chapters, reflect on my study as a whole, consider implications for practice, and discuss my contribution to the field of literature, as well as further research that could follow on from this study.

Chapter 2: Research Design

Introduction

In this chapter I give an outline of my research methodology, and the main methods I used to investigate the experiences of these students, including a rationale for their choice. I then introduce a chronological account of the rounds of data collection including full details of the methods used, and an account of the ethical considerations of the study. Before closing the chapter with my conclusions, I include a section detailing various issues that arose from my data analysis that do not naturally sit within my research chapters.

Research Methodology

Undertaking a longitudinal project the original aim of which was to investigate why students experience undergraduate mathematics programmes in different ways, and why some maintain or develop more positive attitudes than others to the subject, raised many methodological issues. I wanted to be able to gather data on the cohort as a whole, and do comparisons over time, while also gaining more in depth insights from a small sub-group of students, to build up individual trajectories, and provide more insight into their experiences. From the initial conception and planning stages of this study I therefore decided to use both questionnaires and interviews to elicit quantitative and qualitative data from the students.

My decision to choose a mixed methods approach for my study was also made in part through necessity, in terms of bringing my study within scope whilst best attempting to address my research questions, and in itself seemed an uncontroversial decision to make. However, in terms of research methodology, it meant I chose to reject the "incompatibility thesis" as argued by various researchers (e.g. Smith, 1983, Howe, 1988, Guba & Lincoln, 1994) which posits that qualitative and quantitative research paradigms, and their distinct methods, cannot and should not be mixed.

This dispute, which has become known as the "paradigm wars", was most prevalent during the 1980s, and took place in main between the positivists, who use purely

quantitative methods of research, and constructivists and interpretists who favour purely qualitative methods. It started initially due to the reactions of qualitative authors such as Elliot Eisner (1991), Egon Guba and Yvonna Lincoln (Guba and Lincoln, 1985, 1989), and Robert Stake (1995) against the positivistic educational research of the 1960s and 1970s. Many of them argued that constructivism, idealism, relativism, humanism, hermeneutics, and, sometimes, postmodernism (Guba & Lincoln, 1989; Lincoln & Guba, 2000; Schwandt, 2000; Smith, 1983, 1984) were all superior to the positivistic stance of previous research. The bitter debate over the relative merits of these seemingly opposing belief systems were concerned with conceptual issues, such as the 'nature of reality' and the 'possibility of causal linkages'.

Researchers from both paradigms viewed their methods as the ideal for research, and therefore focused on the differences between the two. As Johnson and Onwuegbuzie (2004) describe,

> "Quantitative purists maintain that social science inquiry should be objective. That is, time- and context- free generalizations (Nagel, 1986) are desirable and possible, and real causes of social scientific outcomes can be determined reliably and validly." p. 14

Typically an educational researcher adopting this viewpoint would state and test, or justify empirically, a hypothesis while maintaining an emotional detachment from the study participants, and attempting to eliminate their own biases. They would claim in doing this they minimise their impact on the research undertaken. In contrast, qualitative purists reject the supposition that educational research can be completely objective.

> "These purists contend that multiple-constructed realities abound, that time- and context-free generalizations are neither desirable nor possible, that research is value-bounded, that it is impossible to differentiate fully causes and effects, that logic flows from specific to general (e.g. explanations are generated inductively from the data), and that knower and known cannot be separated because the subjective knower is the only source of reality (Guba, 1990)." p. 14

Before these paradigm wars researchers who chose to use both qualitative and quantitative methods to answer their research questions were not even aware that they were doing anything controversial. What these heated discussions did spark

though was an alternative paradigm, pragmatism. Pragmatists believe that connections between specific paradigms and methodologies are not as clear cut as is proposed by the positivists and constructivists. Rather pragmatists accept that there is a mutual influence between paradigms and methodologies, but believe that integration of differing standpoints may give the best results in many circumstances. Pragmatism is therefore proposed by Johnson & Onwuegbuzie (2004) as,

> "…an attractive philosophical partner for mixed methods research, and to provide a framework for designing and conducting mixed methods research." p. 14

Although mixed method research approaches are still considered as being in their adolescence, over the last decade there has been an ongoing evolution of a more formal recognition of them. This has now become known as the "*third methodological movement*" (Tashakkori & Teddie, 2003), and Leech & Onwuegbuzie (2009) proposed a typology of mixed methods research designs to help further this formal recognition. Researchers are now consciously integrating quantitative and qualitative methods into mixed research designs (e.g. Tashakkori & Teddie, 1998, 2009, and Creswell, 2003) arguing that they are merely selecting their methods in accordance with the research question they are attempting to answer. Thus, as Johnson and Onwuehbuzie (2004) propose, researchers are attempting to,

> "legitimate the use of multiple approaches in answering research questions, rather than restricting or constraining researchers' choices. (i.e. it rejects dogmatism)" p. 17

I therefore return to how I opened this section, by arguing that the research methods I chose to use for my study were initially driven by the research question I started with, and the data I thought would best help me to answer it. As Badley (2003) suggests,

> "What a pragmatic approach to research actually leads to, through reflection, is a kind of useful if temporary equilibrium amongst the community of inquirers. Part of this approach is the rejection of the idea that scientific research can be used with certainty to specify educational practice. All it can provide is possible lines of action." p. 295

My choice to adopt a pragmatic approach to my research design, by choosing initially to combine both qualitative and quantitative research methods, also followed through in my data analysis. However, when my first and second attempts at analysing some of the students' interview data by taking a predominantly

quantitative approach proved fruitless (see later in this chapter for a full description) I adopted a qualitative approach, one actually more akin to social constructivism. Rather than trying to narrow the meanings of what the students spoke to me about into a small number of categories or ideas, I tried to understand the world in which they were living and studying by embracing the complexity of their different views. As Creswell (2009) describes,

> "The goal of research then is to rely as much as possible on the participants' views of the situation being studied. The questions become broad and general so that the participants can construct the meaning of a situation, a meaning typically forged in discussions or interactions with other persons." p. 8

> "Thus, constructivist researchers often address the "processes" of interaction among individuals. They also focus on the specific contexts in which people live and work in order to understand the historical and cultural settings of the participants." p. 8

Within my study I would highlight therefore a shift from a predominantly decontextualised quantitative understanding of the students' approaches to learning, to a qualitative understanding of the broader influences on the student experience, which highlights the social aspects of the students' time at university. However, as will be seen, the quantitative data analysis in Chapter 4 did help me to compare trends within my cohort with those from previous research studies, but then ultimately could not fully explain my results, and I needed to turn to the qualitative data from my interviews to do so. As already mentioned above, two failed attempts at analysing the interview data then led me to take a purely qualitative approach in Chapters 6 and 7.

Research Methods Overview

Choice of Methods

In this section I start to describe the research methods used to investigate the students' experiences, and the reasons for their choice. The cohort I followed was a particular year group of undergraduate mathematics students, studying at a traditional research-led inner city university, through the UK standard three years of their degree. As already mentioned I felt a mixed methods approach would enable me to

combine the relative strengths of both quantitative and qualitative data. The quantitative data would give me an overview of the cohort and help me to investigate trends, but not explain these trends, nor consider individual cases in detail. The qualitative data however could help provide me with much more detail in terms of explaining trends within the cohort, on individual students' experiences, and on the context of the department within which the study was taking place. Various educational research methods books, e.g. Ary et al (2009), Cohen et al (2007), helped me make my decision to collect my data using two main methods, namely large-scale questionnaires administered to the whole group, and interviews with a small sub-group of students. Both of these data collection methods were used to elicit quantitative and qualitative data.

Working initially alongside the SEUM project, I decided to first gather much of the same basic background information about my cohort as had been gathered at the other two universities. This included the students' prior experiences of studying mathematics, and what they liked and disliked about it as a subject, what their expectations were of university in general, and of studying mathematics more specifically. As a lone researcher faced with a cohort of almost 150 students to investigate, I decided in order to keep the study within scope, that the simplest and most convenient way to gather information about the whole group was to administer questionnaires to them.

Using questionnaires would enable me to investigate tendencies within the cohort, and trends over time (by repetition of particular questions). I felt they would also give me a starting point to consider what aspects of their time at university I would investigate further, later on in the study. The main advantages of using questionnaires were that they were relatively quick and easy to for me to administer, and collecting the data in a standardised format made them quite straightforward to analyse. They were also simple and reasonably quick for the students to complete, and combined both closed and open questions thus gathering both quantitative and qualitative data. Also by using questionnaires from other researchers' work, a direct comparison of results from these previous studies was possible.

As with any research method, there are also disadvantages to using questionnaires to gather data. Some students will probably have given instant rather than reflective answers, or even answers they thought would be more acceptable to me as a researcher rather than being completely open in their responses. Also, not all the students completed all five of the questionnaires, or indeed all of the questions in each questionnaire, so data was sometimes missing. As will be seen later in this chapter administering the questionnaires became more difficult during the study, and the last questionnaire had a poor percentage of responses. On occasion questions were also answered in a way that implied that the respondent had either not read the question correctly or had misunderstood, or misinterpreted it, and some students gave up part way through a questionnaire, possibly because they ran out of time, or inclination. I believe that some students also chose just not to complete the latter questionnaires, possibly due to questionnaire fatigue, or just lack of interest, which could of course skew the results as those with an interest in the subject matter were more likely to complete the questionnaires. None of these are uncommon disadvantages found when using questionnaires e.g. Oppenheim (1992)

As well as investigating the cohort as a whole, and any changes over time, I wanted to track the trajectories of some individual students. I decided that the best way to elicit more detailed information from a small subgroup was to interview them regularly during their three years of studying. This would not only give me the opportunity to ask more in depth questions of the interviewees but also explore particular issues that they brought up, and develop new lines of enquiry, with instant follow up questions. I also hoped that interviewing this small subgroup about their experiences would help me to explain any trends found within the cohort from my analysis of the quantitative questionnaire data.

Another advantage of using interviews as a data collection method was I felt that this subgroup of students became more interested and involved in the research than if I had only used questionnaires. Nearing the end of the study some of them asked me more about the research, and other research projects I'd been involved with. However, the disadvantages of interviewing again includes students telling me what they think I want to hear, in the same way this is a potential problem with questionnaire responses. They can also respond quite superficially, through both

nervousness, and through a lack of time to reflect, or simply not wishing to reveal the true situation as due to it being too painful to talk about. Interviewing is also time-consuming in terms of arranging them, performing the interviews (some students chatted on for an hour and a half at a time), subsequently transcribing and then analysing the data. The advantages and disadvantages of using interviews are discussed in detail in many research methods books, for example: Kvale (1996, 2009) and Seale (2004).

In terms of the analysis of my interviews I initially planned to adopt a grounded theory approach (Glaser and Strauss, 1967, Strauss and Corbin, 1998) to allow me to construct concepts from each set of raw data collected, and then build upon these concepts to continually develop the research. After each round of interviews, my plan was to transcribe the tapes and review the transcripts to make note of things specific to each of the students that might be useful to refer to in the next round of interviews (e.g. health issues, accommodation problems). Other than in the initial round of interviews, I would ensure I also asked about particular events that I knew had occurred since we had last met (e.g. exams, summer vacation). By adopting this approach I hoped that the interviewees would feel they were having an ongoing conversation with me, rather than agenda led question and answer sessions. As Kvale (1996) says,

> "A qualitative interview attempts to understand the world from the subjects' points of view, to unfold the meaning of peoples' experiences, to uncover their lived world prior to scientific explanations." p. 1

However, I took maternity leave from my study during the three years of data collection and did not always have time to fully analyse a data set before needing to collect the next one. Also, as already mentioned in Chapter 1, as my study progressed my focus changed and by the final year of data collection I was concentrating on particular themes. These reasons both conceptual and practical made me reconsider my approach, so although I continued to build upon the work I had already undertaken, I do not claim to have adopted a purely grounded theory approach.

As already mentioned, in choosing my research methods I was aware that they were based in very different research traditions, and that purists from those traditions would argue against the use of methods from another, as per the paradigm wars

discussed earlier. However, I feel that the qualitative and quantitative data from both the questionnaires and interviews, complemented one another in my initial analysis (presented in Chapter 4) and compensated for many of the shortcomings detailed already in this section, that are often inherent when using just one or the other type of data. As already discussed, for my analysis of the student interviews I moved to a qualitative approach, the results of which are presented in Chapters 6 and 7.

Data Collection - chronologically

I have chosen to give an account of my data collection chronologically to once again highlight how the original plan for this study has developed and changed since it first began. Table 2.1, on the next page, lists my data collection methods chronologically, when the data was collected, and in which research chapter, or chapters, the data is used. All of the instruments used can be found in the appendices at the back of this thesis.

Year 1

As already mentioned in Chapter 1, Questionnaire A was designed to elicit background information about the cohort e.g. age, gender, prior mathematics examination grades, but it also then covered five main "themes":

- The students' prior experiences of formal mathematics
- The students' choice about going on to study at university
- The students' specific choice of studying mathematics at this university
- The students' finances and living arrangements while at university
- The students' possible future career

The aim was to gather information that enabled me to start to build up a picture of the group as a whole. I administered this questionnaire during induction week of Year 1 in a timetabled session where I introduced myself, and the study. It was important that the students completed this questionnaire before they had been exposed to the context of the new learning environment of their department, as some of the questions posed asked about their expectations of their time at university and their choice of subject.

Year	Collected	Type	Content	Chapter

data collected	during			used
Year 1	Induction week	Questionnaire A	Prior experiences of mathematics	3, 4, 5
	Autumn term	Round 1 of interviews	General background information and getting to know the interviewees	4, 5, 6
	Autumn term	Questionnaire B	Approaches to studying mathematics, and conceptions of mathematics	4
	Spring term	Round two of interviews	A review of the first term and progress to date	4, 5, 6
	End of year	Year on year progression	Compiled through discussion with Departmental Tutor	2
Year 2	Spring term	Questionnaire C	Progress to date	Not specifically used
	Spring term	Round three of interviews	Reacquainting ourselves and reviewing the first half of their degree	4, 5, 6
	Summer term	Round four of interviews	Review of exams and discussion about assessment	4, 5, 6
	End of year	Year on year progression	Compiled through discussion with Departmental Tutor	2
Year 3	Autumn term	Round five of interviews	Revisiting their main influences during previous two years	4, 5, 6
	Spring term	Questionnaire D	Review of 3 years, and Approaches to studying mathematics, and conceptions of mathematics	4
	Spring term	Round six of interviews	Revisiting their attitudes towards mathematics	4, 5, 6
	Summer term	Round seven of interviews	Reflecting on their three years of study and plans for the future	5, 6
End of Years 1, 2 and 3		Exam results	Year 1, 2, 3 (including Yr 1 mid-sessional tests and final degree result)	4

Table 2.1: Summary of data collection

It contained both open and closed questions of various formats; tick box, free-writing, Likert scale, thus eliciting both qualitative and quantitative data. It followed the same basic format of the initial questionnaire devised by the SEUM project with its two cohorts, but was adapted to the context of my study. This questionnaire also introduced some questions that would be used again in the later stages in their degree to allow some comparison of answers across time.

The five “themes” included in this questionnaire related more to my initial research question and aims that ran alongside those of the SEUM project, than my eventual research question, and although the background information, and what the students

liked and disliked about mathematics as a subject at this point in their lives, was subsequently used in this study, much of the information gathered by this questionnaire was not.

Questionnaire A was given to some work colleagues for comment and feedback, and then also piloted with a small group of students from a different cohort, before being used with the group of undergraduates in this study. Despite these two phases of questionnaire trialling and editing some of the students in the study did still appear to misread or misinterpret questions on this, and subsequent, questionnaires, as previously mentioned on p29.

At the end of Questionnaire A the students were asked whether they would also be prepared to be interviewed about their experiences during their degree. I contacted via email all of those who expressed an interest, and set up the first round of interviews with these students. The numbers involved and the course pathways of this subgroup have already been described in Chapter 1.

Two rounds of interviews were conducted this academic year, one in the autumn term and one in the spring term. To help the interviewees feel more at ease initially I gave them all the option of being interviewed in a focus group. One group of four students decided to take up this option and I interviewed them together in the first round of interviews. After this they were all happy to come and be interviewed individually. All of the interviews were semi-structured and examples of the interview schedules used can be found in Appendix V. I used these schedules to prompt me to enquire about particular topics if an interviewee had not spontaneously spoken about them. Thus each round of interviews became less structured as the interviewees became more comfortable with the topics, and with me as an interviewer. Most of the seven rounds of interviews were fully transcribed, but an explanation is included in the following sections for those that were not.

The first round of interviews aimed to elicit further background information on the students by elaborating on the themes of the initial questionnaire i.e. their expectations of their degree course and university in general, their immediate comparison of school and university mathematics, whether they were enjoying

themselves or not, and what they felt about mathematics as a subject. The second round of interviews, in the spring, focussed on the mid-sessional tests the students took at the beginning of that term, as well as how they felt they were settling in, both academically and socially. From these two rounds of interviews, individual "profiles" or "trajectories" were initiated about the interviewees, and were built upon year on year. These trajectories provided me with a way of easily accessing key information on individual students, by continually building up an overall picture of how they were progressing throughout their first two years, and included particular quotes I felt were important to reflect upon. An example of one of these "trajectories" can be found in Appendix VII. As already seen, Table 1.1 summarises some of the more basic information about the eight students.

Questionnaire B (found in Appendix II) was administered during the spring term. This comprised the *Approaches to Learning Mathematics Questionnaire* (ALMQ), developed by Crawford et al (1998a), and the *Conceptions of Mathematics Questionnaire* (CMQ) also developed by Crawford et al (1998a, 1998b). This second questionnaire was administered in much the same way as the first questionnaire, only this time with the kind permission of one of the mathematics lecturers who allowed me to encroach on some of their lecture time.

The decision to investigate the students' approaches to studying, and conceptions of mathematics, to compare these constructs to their exam results, and to look for any changes over time, was made early in the planning stage of the research. I had used both the ALMQ and the CMQ in a study for my MA dissertation, and subsequent journal paper (MacBean, 2004), but with undergraduates not studying mathematics as their main subject area, and without a comparison to exam results. These two questionnaires were both developed by Crawford et al (1998a), the first from the Study Process Questionnaire (SPQ) (Biggs, 1987) and the second from their own previous phenomenographic study (1994). I was interested firstly to see whether results from previous research by Crawford et al (1998a, 1998b) would replicate, but also to investigate whether the students' approaches to studying, or conceptions of, mathematics would change over time within the context of them studying in this mathematics department. This is something that had not been done in any previous research, as far as I was aware.

As stated in Chapter 1, part of the aim of this study was to investigate any relationship between approaches to studying, conceptions of mathematics, and exams results, but also any differences in students' approaches and conceptions over time. The SEUM project had also used abridged versions of these questionnaires, although in the end the results were not reported, but I chose to use the full questionnaires. A detailed explanation as to the scales these questionnaires investigate, and the terminology I chose to use throughout my data analysis, and why I chose it, will follow in Chapter 4.

Part way through the spring term of the students' first year, through to the beginning of the spring term of their second year, I was on maternity leave. However, other data collected (again by kind permission of the Mathematics department) were the mid-sessional test results, taken a week after the Christmas vacation, and the end of year exam results. From these results it could be seen that some students had already left their course. A discussion with the Departmental Tutor elicited the full details of who had left when, and why.

By the end of the first year of the study, 43 of the 142 students were no longer considered to be members of the original cohort:

- 17 had left their degree course entirely, for various reasons throughout the year (see Table 2.2 on next page)
- 8 students interrupted their studies before the end of year exams, intending either to restart the same degree or another, but still within the mathematics department (not all of these eventually did though).
- 18 failed the first year exams and were either retaking the year with part-time revision status, or had left the university entirely.

Main reason given for leaving course	What they intended doing instead	Number of students
They didn't like the course	Intended studying maths somewhere else	3
They didn't like the course	Intended working	2
They didn't like the course	Intended studying something else either still at the same university or elsewhere.	5
They didn't like the city	Intended studying maths somewhere else	3
Illness	Not specified	2
Unknown	Unknown	2

Table 2.2: Reasons given by students for leaving their mathematics degree

Year 2

The third round of interviews took place during the latter half of the spring term of the students second year, since no formal lectures occur during term three due to the examination timetable. Their focus was to start to enable the students to reflect back on their degree so far, covering most of their first two years of teaching.

Questionnaire C (found in Appendix III) was handed out in two lectures just before the Easter break, and was completed by 42 students (42 per cent of the cohort at this point). I designed this questionnaire to follow up on some of five themes introduced in Questionnaire A, and therefore enable a comparison of the students' experiences of their first and second years. Once again open and closed questions were used, including some tick box, multiple choice, and sliding scales. As already stated, as my research developed, and my research questions changed focus, much of the information gathered by this questionnaire was not eventually used.

The fourth round of interviews took place during the summer term after their exams, primarily to discuss how they felt their exams had gone and to talk more generally about assessment. Due to the timing of these interviews only 5 of the 8 students were able to attend. Again these interviews were fully transcribed, and were used in combination with the previous three rounds of interviews to inform the structure for the interviews undertaken in Year 3.

These interviews during Years 1 and 2 were deliberately broad in scope, covering two main areas: the academic side of the students' time at university, and everything

else that they considered to be part of “student” life. I allowed the interviewees to discuss with me anything they felt was important under the umbrella of these broad topics. I would begin each interview with very open questions e.g. “Could you tell me a bit about yourself?”, “How has everything been going since we last met?” and let them talk until they had exhausted a topic. However, I also had specific lines of enquiry for each student that had been collated by reviewing their previous interview transcript. I would prompt the students to talk about those they did not bring them up themselves.

Year 3

During the autumn term of the students’ third year, the fifth round of interviews took place, focussing on what the students felt had been the main influences upon them during the previous two years. This took the form of a set of categories from a pre-determined list, drawn up by analysing the previous two years of interviews, from which the students chose topics to discuss that they felt had been important to them during different periods of their course.

Following the fourth rounds of interviews at the end of Year 2 I had started the process of open coding the transcripts to date, by looking for factors that would have an influence on the majority of undergraduate students no matter what they were studying, rather than things that were specific to those studying mathematics. In relation to my research question, my primary aim for my fifth round of interviews was to investigate any patterns in these students’ experiences over the period of their degree by asking them to think back to specific time frames, and choose what factors they felt had most influenced them at the time.

I continually added to my list of codes until I had reviewed all of the interviews, but I did not keep a tally of how many times each was mentioned; if a code had been mentioned previously it was not added again. I then cross referenced my list of codes, sometimes combining them, and ended up with 19 “categories”. I acknowledge here that these codes were to some extent prompted by the lines of questioning that I instigated with the students during their interviews. However, I hoped that by open coding the interviews to date I would be including not only the factors that I had

introduced to the interviews by my questioning, but also any other factors that the students had brought up independently.

My aim in doing this was to use these 19 categories as prompts in the next round of interviews, both to elicit more detailed information from the interviewees as to how they had felt about different issues at particular times during their three years, but also to enable them to reflect on how they felt about these issues now that they were nearing the end of their degrees. The advantage I felt of this process was in my reviewing of the interviews to date. Re-reading the interviews, looking specifically for factors that influenced them during the previous two years, not only helped me to reconnect with the data, some of which I had not read for over a year, but to review and reconsider any assumptions I had made when preparing my interview schedules for the previous four interview rounds.

The final 19 categories were not entirely independent, but I felt at the time that they were specific enough for the students to be able to relate to them, and yet broad enough to cover the full range of issues previously discussed. I also thought that any more than this number of categories would be too many to ask the students to decide between. Although not discussed with the interviewees, I grouped these categories under the four themes of:

- *Social/personal life* - Friendships, Being a member of clubs or societies, Socialising and drinking, Health issues, Relationships and partners.
- *Academic life* – Lectures, Coursework, Lecturers, Tutorials, Problem Classes, Exams.
- *Home life* – Rented accommodation, Living at home, Halls of residence, Household chores, Financial management.
- *Work life* - Paid employment during term time, Paid employment during university vacations, Volunteer work.

These 19 categories were typed up with each one on a separate piece of card. For the fifth round of interviews the cards, each with a different category on it, were laid out in front of the student at the start of the interview. They were asked to pick the three categories they felt had had most influence on them during the 1st term of the 1st year, and to rank these three in order of importance to them. They were then asked to

justify and discuss each of their choices in turn. Once the discussion about each of these three items had been exhausted they were asked to do the same again but now considering the time period of the rest of their first year (i.e. the spring and summer terms), and then again for the 2nd year.

At each stage the interviewee was also given the opportunity to suggest other categories that weren't in the 19 put forward, but none of them did. Also, at the end of this round of interviews, only one of the categories used in this process had not been chosen by any of the students. I felt that these both help confirm that the process of open coding had captured those factors the students had felt were of more influence on them during the previous two years. Once we had covered the three time periods in this way, we then continued the interview with a more general discussion of how their third year was progressing.

Then during the spring term of the students' third year the sixth round of interviews was conducted focussing on the students' attitudes to mathematics. Again the transcripts from the first four rounds of interviews were reviewed, but this time with a view to finding quotes from the students relating specifically to their attitudes towards mathematics as a subject. Fifteen such quotes were found in total, all of which were judged that they would illicit a reaction from the interviewees, and therefore stimulate further discussion (see appendix VI for the fifteen quotes used) These quotes were also felt to be independent and between them cover the area in terms of varying attitudes expressed at different periods during the students first and second years. The quotes were each typed up on separate sheets and anonymised, but put in context by a footnote as to when they were said and by whom e.g. "First term, first year, by a joint honours student".

The students were asked to read a quote and react to it saying whether or not they agreed with it now, and whether they thought they would have agreed with it at the time it had been said. In this way, the students would sometimes be reacting to things they themselves had said in a previous interview, and for the rest of the quotes to what the other interviewees had said in the past. Once they had exhausted what they had to say about a particular quote I moved them on to the next one, until all fifteen

had been spoken about. In this way I hoped to gain a picture of changes in these students' attitudes over their degree course as per my overall research question.

Nearing the end of Year 3 Questionnaire D (found in Appendix IV), the final questionnaire, was administered to the students. This was done just before the Easter vacation, so at a time when lectures were still taking place. It comprised firstly of four "open" questions:

- What have you enjoyed most about your degree course?
- What have you enjoyed least about your degree course?
- How much do you enjoy maths now compared to at the end of your A-levels? And why?
- In what ways has your view of what maths is changed over the last three years?

These were followed by the ALMQ and the CMQ (i.e. the same as Questionnaire B, detailed above). Questionnaire D was therefore very important in terms of gathering the quantitative data that provided the longitudinal aspect of my study by enabling me to make a comparison of the students' approaches to learning mathematics, and their conceptions of mathematics, near the beginning and end of their degree course.

One final round of interviews were conducted after the students' third year exams during the summer term. They were asked to reflect on their time studying and on their plans for the future. These particular interviews were not transcribed directly after they took place. When they were eventually reviewed, it was during a round of data analysis spanning the interviews from all three years. It was therefore decided that only a partial transcription of this round of interviews was necessary, as particular themes were being investigated at the time.

In describing my research design I started with this chronological account of the data collection and the methods used to give an overview of the study. I now describe issues arising from the use of these two main methods of data collection (questionnaires and the interviews), before turning to ethical considerations that have arisen during my research.

Issues arising from my use of these research methods

Administration and completion of the questionnaires

Questionnaire A was the longest of the 4 questionnaires in terms of the estimated length of time that it would take the students to complete. As previously mentioned, it was therefore administered in a timetabled session during induction week soon after the students first arrived at university, and before their lecture courses had begun. At the start of this session, which took place in a large lecture theatre, the research study was explained to the students, and they were asked to complete the questionnaire and hand it in before leaving the room. These scripts were left in a pile so students could always decide not to complete it and hand the blank questionnaire in, but most students who attended the session did complete it. Those students who missed this session were contacted either through their tutor, or via email, and asked to complete the questionnaire in their own time, but only a few did. As I subsequently discovered there were a significant number of students on the original list given to me by the department who never enrolled, dropped out, or changed courses within the first few weeks of the first year. These students would not therefore have counted in the departmental attrition figures.

I tried to ensure that the students completed the questionnaires under similar conditions, although this was not always possible. Firstly I did not want them to take much time to think about their answers, therefore giving their gut reactions to the statements, and secondly I did not want them to discuss the statements with their peers and be influenced by others' responses. So the ideal was that the questionnaire was therefore handed out in a lecture theatre, the students asked to complete it in silence, and the majority of the questionnaires then collected approximately 15 minutes later. However, those students who had not fully completed the questionnaire at the end of these 15 minutes were asked to return it once they had done so, either via the university's internal mail or by placing it in a box in their departmental office. Also, those students who were emailed a questionnaire were requested to complete it alone, and as quickly as possible

Questionnaire D, administered in Year 3, proved to be the most difficult one to coordinate as the students were now taking so many different optional modules, and

so were never taught all together in one place. It was therefore decided to target the most popular courses for handing out the questionnaires direct to the students, to try to catch as many of the cohort as possible, in as few different courses, and the lecturers involved kindly agreed to this. Those students who were not given questionnaires in this way were emailed the document, asked to complete it in their own time and to return it via their departmental office. Unfortunately the response rate was still quite low, and only 32 per cent of the students completed questionnaires and returned them. In retrospect other ways of distributing the questionnaire should have been investigated at an early stage to improve this completion rate.

Interviews

As already mentioned one of the disadvantages of using interviews in terms of their validity is that students will sometimes say what they think the researcher wants to hear, or give a superficial answer due to the lack of time to reflect on the question. I hope I alleviated this in part by a process of reiteration and reflection, and enabled the interviewees to open up more than they may have the first time they were asked about their experiences. This certainly seemed to be the case during the final few rounds of interviews, when they were prompted to reflect on their experiences and attitudes in the previous two years. For example a couple of the interviewees told me things that had been going on in their lives that they had chosen not to talk to me about at the time, and similarly shared particular opinions for the first time when reading the quotes from other students about their attitude to mathematics during the sixth round of interviews.

One problem that I did not always manage to overcome was managing to schedule interview times with each of the eight main students for each round of interviews. This became more difficult as the study progressed both in terms of increased time pressures on the students, but also due to myself dropping down to part time working. For example, following up from the fifth round of interviews that investigated factors influencing these students during Years 1 and 2, I intended looking again at these influences in the final round of interviews with the students, and this time ask them to consider the factors in terms of their third year. This seventh round of interviews were due to take place following the students' final year examinations, but these proved very difficult to timetable as many of the students either headed abroad for a

holiday, or home to see family straight after their examinations finished. In the end I merely chatted to the few students I managed to interview about their third year experiences, rather than following the same systematic approach using prompt cards that I had adopted in the fifth round of interviews.

Ethical considerations

I approached the Mathematics department where this study took place with my initial research proposal in early 2001, and gained their agreement to work with their intake of first year students starting in the academic year 2001/2002.

The decision to approach this particular department was two fold. Firstly I already had a good relationship with some of the members of staff, having both studied there, and worked with groups of their students previously in my capacity as Peer Assisted Learning Coordinator (as described in Chapter 1). Secondly from a purely practical perspective I was working at this university and my office was reasonably close to the mathematics department. This meant that I could visit the department on a regular basis to administer questionnaires, meet the departmental tutor, and visit their departmental office. It also enabled me to invite the subgroup of students to be interviewed away from their department, allowing them some distance, both physical and mental, from it. The interviews therefore all took place in the building where my office was situated, in rooms where we would not be disturbed during the interview process.

However, as an ex-student of the mathematics department in which this study took place, as well an employee of the university and researcher working with lecturers within this mathematics department, many ethical issues needed to be taken into consideration. Discussions took place with both the departmental tutor and other members of lecturing staff as to the nature of my study, before it began, and agreement was gained for me to be allowed access to this cohort, in terms of dedicated time for their completion of the first questionnaire, as well as certain data, i.e. students examination results year on year and details of the progression, and drop out, of students in this cohort. This was on condition that I would comply with data

protection guidelines at all times, in terms of password-protected storage of information, and the anonymising of all data relating to individuals within this study.

I do feel that my having these prior relationships with members of staff in the department helped facilitate this process in terms of gaining access to departmental information and data. It also helped considerably in gaining access to the students' time, in reading week initially, and then later at the start or end of lectures, for the distribution and administration of questionnaires. Members of staff within the mathematics department were helpful and accommodating throughout the study.

From the outset of the study I also made it clear to the cohort that all of the information they provide, either via questionnaire or interview would be anonymised both within this study, and during any discussions with members of staff within their department. In other words any issues they wished to raise with me would only be fed back to their department in general terms and their identity would remain unknown to their lecturers. I also let all the students I interviewed know that I had studied in this mathematics department, that I worked at the university still, but not in their department. I felt that this helped the students speak to me more openly, and also ensured the conversation flowed without, for example, them having to constantly explain how their courses were structured, etc.

However, there may still have been some hesitance from the students in their interview and questionnaire answers with them knowing my involvement with the department in which they were studying, and my position in the university. For the interviewees this did appear to diminish over time as they became more comfortable with me, as in their third year they reflected on their previous two years and mentioned experiences that they hadn't done so at the time. Also, I fully acknowledge that my history with this department means I have a level of commitment and attachment to it that may well have led to me showing particular bias in the questions I asked, the way that I asked them, and the way my analysis has interpreted the students' answers.

Although the students were encouraged to complete all the questionnaires by the allocation of time for their completion, the initial questionnaire during reading week,

and subsequent questionnaires during the last 10-15 minutes of particular lectures, it was always acknowledged that it was their choice whether or not to complete them. They could if they chose hand a blank questionnaire back in at the end of the allocated time. Similarly those students who I interviewed were given the option to withdraw from the study at any time, and although not all 8 students managed to come to every round of interviews, due to other priorities they had during those periods, none of them chose to withdraw completely from the study.

In terms of ethical issues from the perspective of the lecturers mentioned in the students' interviews, and indeed the department as a whole, every attempt was made to ensure the anonymity of both. None of the lecturers names are used throughout this thesis, nor is the name of the University in which the study took place. As there was only one female lecturer working in the department at the time, the decision was made to refer to all of the members of staff as though male, thus ensuring her anonymity. The only exception to this rigourous anonymising is that many of the students referred to a particular topic of study, i.e. Analysis. It was felt that although some of these references were specific to Analysis in their first year of study this topic was taught by at least two different lecturers during the course of the year, and it was more important to raise this topic as an issue than preserve the anonymity of the members of staff who taught it. This decision was also justified by the fact that the study took place long enough ago that it would be difficult for any reader of this thesis to ascertain exactly which members of staff were teaching the Analysis courses when the students make reference to it.

Luckily the issue of being both a researcher and the PAL coordinator within the department was minimal. None of the students who participated in the interviews for this study volunteered as PAL leaders in their second year. Those students who did become PAL leaders and were therefore involved with me in another capacity only participated in the study in that they were asked to complete the questionnaires as they were part of the total cohort.

Issues arising from my data analysis approach

As already detailed in Chapter 1, each of my research chapters deals with a particular research question and the data analysis is presented there. However, what these chapters each present is a completed analysis, so I take the opportunity here to present some of the lead up to these chapters, both in terms of the development of my analysis, some of which has not been fully presented but that is relevant background, and the data analysis approaches I tried and subsequently abandoned.

Questionnaires

Some data collation, and initial analysis, was done during the three years of data collection, while the cohort was still enrolled on their degree. For example the basic background information gathered on the cohort, why the students chose to study mathematics, what they liked and disliked about it as a subject. Primarily this was information elicited by Questionnaire A.

However, once the students had completed their degrees, or moved into their fourth year of study for those staying on to take the MSci, and my data collection stage was mostly complete, I decided to first concentrate on analysing the quantitative data from the students' questionnaires on the approaches to studying, and conceptions of, mathematics. Comparison of these scales, both over time i.e. between the first and second time the questionnaire was administered, as well as with the students' examination marks, highlighted differences between my results and those of previous research in this field.

Interviews

As described above the interview transcripts were briefly analysed after each set of interviews, primarily to continually inform the next round of interviews, to try to ensure that the participants experienced them as an ongoing dialogue. However, as already mentioned, during the three years of the students' degree the changes in my personal circumstances meant that there was little time for this ongoing data analysis, because the next data set often needed to be collected. I was however keen to keep my study a longitudinal one, and so prioritised data collection at the expense of a fully grounded theory approach to my analysis, which would have built more upon each set of data before embarking on the next round of data collection.

Also, as with most research studies, external factors and subsequent decisions along the way have changed the focus of this final reporting somewhat from what was initially proposed when the project was first conceived in 2000. This section therefore gives a chronological account of this study in terms of the data analysis of the interview transcripts that occurred after the three year period of primary data collection.

As already noted, the first data analysis undertaken, once the main data collection phase had been completed and the students had finished their three year degree course, was the quantitative data gathered from the ALMQ and CMQ, both times they were administered (i.e. Questionnaires B and D). Differences between my results and those of previous studies prompted me to investigate four students as case studies by comparing two who had done well academically in terms of examination results, and two who had struggled more, looking at both their questionnaire data and their interviews to try to provide an explanation of the differences between my results and those of previous studies. This statistical analysis of the ALMQ and CMC data and the case studies of these four students, form the data analysis presented in Chapter 4.

In analysing these students' interviews I started by rereading the transcripts and identifying quotes that highlighted aspects of their conceptions of mathematics and approaches to learning mathematics. The extracts chosen were therefore selected because of their direct relevance to the themes investigated by these questionnaires. As will be seen in Chapter 4 these quotes also highlighted contextual factors that helped with a possible explanation of why the statistical results from the quantitative data differed from those in previous research.

I next turned my attention specifically to the fifth and sixth rounds interviews that took place during the student's third year. I started by analysing the fifth round of interviews that took place in the autumn term, which focussed on the main influences the students had spoken about during the previous two years.

My first round of data analysis from this fifth round of interviews attempted to produce a typology of the students by investigating the themes: Home life, Academic

life, Social/Personal life, Work. These were drawn together from the 19 pre-determined categories that the student chose from to discuss what they felt had been important to them in Years 1 and 2. Table 2.3 shows again these 19 categories, and how they were group under the four theme headings.

Social / Personal	Academic life	Home life	Work
Friendships	Lectures	Rented Accommodation	Paid employment during term time
Clubs and societies	Coursework	Living at home	Paid employment during the vacations
Socialising and drinking	Lecturers	Hall of residence	Volunteer work
Health issues	Tutorials	Household chores	
Relationships and partners	Problem classes	Financial management	
	Exams		

Table 2.3: Categories used for interviews on main influences during students' degree courses

Table 2.4 (on the next page) then shows the categories each of the students chose to talk about and the ranking they gave them in terms of importance. I've highlighted each of the four main categories in different colours red=social/personal, blue=academic, green=home life, pink=work

I then tried to gain an overall picture of what they felt was important in terms of different influences at different times, and draw together their experiences through the four themes. I gave each of the students' three choices of category a point "score" designation. Rank 1, which was the category they had chosen to be of most influence, was given point designation = 3, through to rank 3, which was given point designation = 1, indicating it was of least influence. It felt more intuitive to have the category of most influence having a high "score", so by changing from using the ranks to point scores, I produced Table 2.5 (on page 51) that shows the overall totals in the 3 different time frames. Looking at this we can see clearly that these students chose categories under the theme of academic life as having the most influence, followed by home life and social/personal. Initially, the students' focus was on lectures and coursework, but this shifted towards exams in the second half of their

first year. Exams were again dominant in their second year, and lecturers made their first appearance in the students' choices.

	Rank	1st term 1st yr	2nd + 3rd terms 1st yr, + summer vacation	2nd yr
James	1	Clubs and societies	Halls of residence	Rented accommodation
	2	Volunteer work	Friendships	Health issues
	3	Lectures	Exams	Lectures
Steve	1	Lectures	Exams	Relationships and partners
	2	Friendships	Lectures	Exams
	3	Living at home	Coursework	Socialising and drinking
Sarah	1	Halls of Residence	Exams	Exams
	2	Lectures	Lectures	Rented accommodation
	3	Friendships	Rented accommodation	Paid employment during the vacations
Yen	1	Lectures	Exams	Lectures
	2	Halls of Residence	Rented accommodation	Rented Accommodation
	3	Financial Management	Paid employment during the vacations	Financial Management
Rafik	1	Living at home	Exams (specifically mid-sessional tests)	Lecturers
	2	Friendships	Paid employment during term time	Coursework
	3	Problem classes	Tutorials	Paid employment during term time
Hakim	1	Lectures	Exams	Friendships
	2	Course work	Tutorials	Lecturers
	3	Hall of residence	Lectures	Rented Accomodation
Jane	1	Friendships	Rented accommodation	Exams
	2	Hall of residence	Socialising and drinking	Paid employment during the vacations
	3	Lectures	Paid employment during the vacations	Socialising and drinking
Lyn	1	Relationships and partners	Exams	Exams
	2	Coursework	=Health issues	Health issues
	3	Hall of residence	=Relationships and partners	Rented accommodation
Charlotte	1	Hall of residence	Exams	Financial management
	2	Coursework	Relationships and partners	Volunteer work
	3	Tutorials	Hall of residence	Paid employment during the vacations

Table 2.4: Categories the interviewed students chose as main influences during different time frames, including rankings in order of importance. Please note that Adam is not included in this table due to data loss – only part of his interview was successfully recorded.

Overall totals of rankings for each time frame	1st Term 1st Year	2nd + 3rd Terms 1st Year + vacation	2nd Year	TOTALS overall
Academic	21	31	22	74
Social	14	9	12	35
Home	17	10	13	40
Work	2	4	7	13

Table 2.5: Totals of rankings for each of the four themes for the different time frames

However, when my attention then turned in more detail to the analysis of all three years of interviews, and I attempted to draw the students' experiences together, I drew a blank. Although it seemed from these results that the students felt that academic aspects of their degree were most important during each of these time frames this didn't seem to correlate with what they had discussed with me at the time. Their interviews were dominated by discussions of their home and social life. I also felt that the distinction I had made between social and home life was an ambiguous one, and therefore abandoned these four themes as a way of combining the 19 categories.

After a long period away from my data, due to me being on maternity leave for the third time, I started afresh with a different approach to the analysis of the interview data, by trying to group the students in terms of "type", by using a quantitative formula based on their order of choice of the 19 categories. In other words, instead of focusing on these four themes, I attempted to produce a typology of the students. I tried then to present the data in terms of 3 "composite students" created from grouping students together, and then cutting the data longitudinally. The groupings of interviewees to form the 3 composites were:

- Hakim, James and Lyn
- Steve and Rafik
- Sarah, Yen, Jane and Charlotte

and although there were similarities between the students in each of the 3 groups, this approach felt forced, and ultimately I abandoned it also.

Influenced partly by attending the ESRC funded seminar series, "Mathematical Relationships: Identities and Participation" (Mendick, 2006) in 2006/07, and partly by reading other literature in the last few years, I was spurred on to try yet another approach at analysing the interview data, this time looking again at the interviews

across the three years, and this time focussing primarily on what the students said about their interactions with others. This brought to the forefront issues of how they coped, both as individuals and in small groups, in terms of "belonging" during their time at university. Exploring what the students said about themselves in terms of their interactions with other students, in varying contexts, and also members of staff, as well as some background reading on retention and attrition amongst undergraduates, including work by Spady (e.g. 1970) and Tinto (e.g.1975) on social and academic integration, led me to the decision of splitting my analysis between two overarching themes of social and academic support, whilst recognising and acknowledging the overlap between the two. It is from this approach to my data analysis that Chapters 6 and 7 of the thesis evolved.

Conclusions

The research approach I have presented in this chapter was designed to build up a picture of these students' experiences at this university, and of studying in this mathematics department. I have detailed my research methodology and, within the limited resources available to a lone researcher, the methods I chose to use. While no method is perfect, had I made different choices they would have been problematic in their own ways, and I have detailed how I attempted to overcome some of the difficulties often inherent in the methods chosen.

In the literature review and research chapters that follow I detail the outcomes from the research process I have outlined here. In Chapter 8, my concluding chapter, I will examine any shortcomings of the approach taken and suggest ways in which this research could have been improved, as well as any future research that could build upon the work already done here.

Chapter 3: Literature Review – Approaches to studying, conceptions of learning, and attitudes to mathematics

Introduction

As already mentioned in Chapter 1, two of my data analysis chapters in this thesis start with a theoretical background section related directly to the data analysis being presented. This chapter reviews the literature that provided the background and framework for the original notion of my study. However, as will start to become apparent in Chapter 4, my data analysis of the students' interviews took my study in a different direction, and introduced a new structure and framework, the background literature of which will be presented in chapters 5, 6 and 7.

There has been an explosion in research on student learning in Higher Education over the last two decades, but as Haggis (2009) states,

> "In the context of higher education, 'student learning research' is frequently taken to refer to the Approaches to Learning research, originated by Marton & Saljo (1984/1997) in the 1970s, and developed around the idea of 'deep' and 'surface' approaches to learning." p. 377

I too decided that one of my starting points in terms of data collection would be with the students' approaches to studying, and conceptions of mathematics. As already mentioned, I had used these concepts, and questionnaires from prior research studies, in my MA dissertation, comparing two groups of undergraduates. This time I was interested in investigating whether there were any significant changes in one group of students' approaches and conceptions, over the period of their degree course.

I use this chapter therefore to provide a synopsis of the origins of this generic research on student learning, its strengths and weaknesses, and current thinking from those researchers who have championed it, before turning my attention more specifically to the learning of mathematics at undergraduate level. I then place my study in the field of mathematics education by giving a brief overview, before narrowing down my literature review to the affective aspects of learning mathematics

and more specifically by investigating the literature on students' attitudes to mathematics. I bring the chapter to a close by returning to research on students' approaches to studying and conceptions, but by looking at the subject specific work with mathematics undergraduates, initialised by Crawford et al (1994, 1998a, 1998b) and built upon by researchers over the last decade e.g. Mji (2003), Reid et al (2003, 2005), Petoscz et al (2007) and Houston et al (2010).

The implications of this literature are discussed and this leads into Chapter 4, where I present the data analysis of questionnaire data gathered on this student cohort in terms of their approaches to studying, and conceptions of learning. As will be seen my analysis led to results that conflicted with previous research, and this provoked further investigation using four student case studies, looking at their questionnaire data but also their qualitative interview data to take into account contextual factors. This analysis was originally completed five years ago, but has been revisited in light of more recent literature.

Higher Education research on student learning

Students' approaches to studying and conceptions of learning have been referred to in research as the 'how' and 'what' of learning, with students' approaches to studying being seen as the structural aspect, and their conceptions as the referential aspect of learning. They have dominated research on student learning in higher education since they were first reported on in the late 1970s, so I provide here an overview to date.

Research by Marton and Säljö (1976) first distinguished two main approaches to learning when they investigated students' processing of a reading task. A group of students were given an article to read and then interviewed about the content of the article, and how they tackled the task set. The researchers were interested in discovering why the students arrived at qualitatively different ways of understanding the text as a whole, and what emerged was a relatively simple picture of what occurred. The main difference was that some students concentrated on the text itself, by memorising as much as they could, while the others focussed on what the text was actually about by trying to understand the author's reasoning, drawing out the main

points and relating them to their own experiences. These two different approaches were referred to as *surface* and *deep* respectively.

Similar research by Svensson (1977) also found this variation in cognitive approach and described the styles as *atomistic* and *holistic*. The major difference between the atomistic/holistic and surface/deep paradigm is one of an analytic separation of the structural and the referential, or once again the 'how' and 'what'. This is due to the differing epistemological assumptions of the researchers. As Svensson reports, he

> "was concerned to retain evidence of both outcome and process within his initial analysis. Marton concentrated first on process, before examining relationships with outcome." p. 233

Säljö (1979) addressed the relationship with outcome, in terms of the referential aspect of learning, when he reported five ways in which academic learning was conceptualised by students as: an increase of knowledge; memorising; acquisition of facts, procedures etc., which can be retained and/or utilised in practice; abstraction of meaning; and an interpretation process aimed at the understanding of reality. These conceptions of learning have also proved to be important, with research evidence showing that they have a strong influence upon the study approach that students adopt for different academic tasks.

Further work by Marton et al (1993) subsequently characterised these five conceptualisations in greater detail, and an additional sixth conceptualisation of 'changing as a person' was proposed. These authors also made the distinction between conceptions and categories of distinction, finding that students understood learning in six qualitatively different ways, and that these were found to be hierarchical in their nature.

> "Learning was seen as:
> (A) Increasing one's knowledge
> (B) Memorising and reproducing
> (C) Applying
> (D) Understanding
> (E) Seeing something in a different way
> (F) Changing as a person" p. 283-284

During this same period, further related research (Biggs, 1979, Entwistle & Ramsden, 1983) on approaches to studying argued that there was evidence to suggest a three-factor model that consisted of *deep*, *surface* and *achieving* approaches to learning. An achieving approach was characterised as one where the student is very strategic in their studying, constantly looking for cues from the lecturer, which at the time was suggested to be due to an overall lack of interest in the subject area.

Many research studies into students' approaches to studying were undertaken in the 1980s using questionnaires with students e.g. Entwistle (1981), Clarke (1986), Entwistle & Waterson (1988). During this period Ramsden and Entwistle (1983) compiled an inventory of what they called the different orientations that students adopt in their approaches to studying, introducing the terms *meaning*, *reproducing* and *achieving* orientations, along with *styles and pathologies*. A summary of the sub-scales contained in these orientations is shown in Table 3.1. Marton and Säljö's original two-approach model to students' studying had become a much more complex four-approach, sixteen-subscales model.

I would argue that Entwistle and Ramdsen's orientations provide a broader description of the process than Marton and Säljö's simple deep and surface learning model. However, Richardson (1990) found that only the meaning and reproducing orientations achieved satisfactory levels of reliability, when attempting to replicate Entwistle and Ramdsen's work with several groups of students, leaving the remaining study orientations and constituent sub-scales 'open to question'. Kember & Leung (1998) also found that approaches to learning as best described by a two-factor model. These findings have to be taken into account therefore when researching students' approaches to studying, especially in a small scale study such as mine.

Marton (1993) also argued that students do not necessarily stick to one set approach to their studying. He proposed that students adapt their approach depending on the context and nature of the academic task, moving between different orientations. This flexibility in their approach to studying had been reinforced by research done by Laurillard (1979). Biggs (1987) later argued that these researchers placed too much emphasis on the situated nature of a student's approach. He believed that students

have a predilection to adopt a certain approach, and while this can be changed, it does so only if compatible with the motivations, abilities, locus of control, and other deeper personality factors that shape those predilections.

Studies by Crawford et al (1994, 1998a, 1998b) explored both the structural and referential aspects of learning mathematics at university, by looking at undergraduates' approaches to learning mathematics and conceptions of mathematics. I discuss their work, and more recent research in this area, later in this chapter when discussing undergraduates' learning of mathematics more specifically.

Scale	Subscale	Meaning of subscale
Meaning orientation:	Deep approach	Active questioning in learning
	Inter-relating ideas	Relating to other parts of the course
	Use of evidence	Relating evidence to conclusions
	Intrinsic motivation	Interest in learning for learning's sake
Reproducing orientation:	Surface approach	Preoccupation with memorisation
	Syllabus-boundness	Relying on staff to define learning tasks
	Fear of failure	Pessimism and anxiety about academic outcomes
	Extrinsic motivation	Interest in courses for the qualifications they offer
Achieving orientation:	Strategic approach	Awareness of implications of academic demands made by staff
	Disorganised study methods	Unable to work regularly and effectively
	Negative attitudes to studying	Lack of interest and application
	Achievement motivation	Competitive and confident
Styles and Pathologies:	Comprehension learning	Readiness to map out subject area and think divergently
	Globetrotting	Over-ready to jump to conclusions
	Operation learning	Emphasis on facts and logical analysis
	Improvidence	Over-cautious reliance on details

Table 3.1: Sub-scales contained in the original Approaches to Studying Questionnaire (Compiled from source: Ramsden and Entwistle (1983))

Factors affecting students' approaches to studying

Many studies have investigated different factors that can have an effect on students' approaches to studying, but I concentrate here on just two: gender and age.

Richardson (1993) investigated whether there were gender differences in students' approaches to studying and concluded that there 'was no consistent evidence of significant difference between men and women in terms of their scores on individual items, sub-scales, or learning orientations'. However, subsequent work by Magee et al (1998) claimed that there were significant gender differences for deep and surface approaches, but not for the achieving approach, within their student sample. Female students were more likely to adopt a deep approach than male students, and male students were more likely to adopt a surface approach than female students. Conversely, Greasley (1998) concluded that the female students in her sample had a high fear of failure, took a highly strategic approach and were also more likely to adopt a surface approach than their male peers did.

Anthony (2000), in an investigation into factors influencing first-year students' success in mathematics, found no statistically significant differences between male and female students. She concluded that,

> "assuming students' perceptions influence their learning approaches, then the overall lack of differentiation by gender offers support to Richardson's assertion that there is no significant difference between male and female responses to approaches to studying." p. 9

I would argue that the differences between the results of these studies shows that gender alone is not a major influence on students' approaches to learning. It could be however that, in studies where a difference is found, other contextual factors of the study (be that on an institutional, discipline or departmental level) are highlighted in differences of gender.

In terms of student age, however, Richardson (1994, 1995) and Magee et al (1998) are in agreement that it is a factor that consistently affects students' approaches to studying. Mature students are more likely to adopt a deep approach, and less likely to adopt a surface approach than the younger students. Richardson (1994) offers three possible explanations for this:

> "that mature students are more motivated by intrinsic goals; that younger students acquire a surface approach to learning in the final years of secondary education; and that the prior life experience of mature students promotes a deep approach toward studying in higher education." p. 309

Teaching and Assessment Methods

So far in this section I have focussed on the students' approaches to, and conceptions of, learning with no mention of teaching. Studies by Thomas and Bain (1982, 1984) also proposed that students have both stylistic and strategic aspects in their approaches to studying, and argued that students change their approach to studying according to content area (e.g. psychology, mathematics, English language) and the type of assessment method used. However, they also proposed that students tend to operate within the broad limits of an approach, especially with regard to a deep approach. So, those students who adopt a deep approach tended to do so whatever the content area or assessment method, whereas a surface approach can be influenced by the assessment method used, being more prevalent, for example, when the assessment is via multiple choice style questions (Scouller, 1998).

During the 1990s a whole area of parallel research on lecturers' conceptions of, and approaches to, teaching was taking place. It was argued that students' perceptions of teaching and assessment procedures directly affect their learning. For example, a study by Kember and Gow (1994) identified two orientations of lecturers' teaching in higher education, *knowledge transmission* and *learning facilitation*. The former is made up of four sub-scales; training for specific jobs, use of media, imparting information, and knowledge of subject, and the latter of five sub-scales; problem solving, more interactive teaching, facilitative teaching, pastoral interest and motivator of students. Their study goes on to suggest,

> "That the methods of teaching adopted, the learning tasks set, the assessment demands made, and the workload specified are strongly influenced by the orientation to teaching." p. 63

Moreover, this research also suggested that the knowledge transmission orientation to teaching is linked to students adopting a surface approach to their studying, whereas the learning facilitation orientation is more likely to induce a deep approach to studying from students.

This distinction between knowledge transmission and learning facilitation orientations can also be seen in university teaching and assessment of mathematics,

as put forward in the following extract from Uhl and Davis (1999) speaking from their perspective as mathematicians.

> "MacLane (1994) offered:
>
> *'intuition – trial – error – speculation – conjecture – proof'*
>
> as a sequence for understanding mathematics. In contrast, the sequence in place in most modern mathematics courses is:
>
> *lecture – memorisation – test*
>
> Most working mathematicians agree with MacLane's description, thus leaving the inescapable conclusion that the mathematics we do is not the same as what is commonly offered in the classroom." p. 67

Burton (1999) reiterates this view that many mathematicians do not teach in the same way that they actually practise mathematics. She puts forward an explanation where,

> "with each new generation of teachers who have never encountered the excitement and frustration and whose learning has always been dependent upon a didactic and transmission-based model, there is no alternative experience for them to draw on in their own practices". p. 140

More recent work by Burton (2004) further investigated research mathematicians' ideas about mathematics and coming to know mathematics. In her model she conjectures that coming to know mathematics is a product of people and societies that is inter-dependent with feelings, that is intuitive and inter-connects in networks. As she points out this is in stark contrast to the widely accepted view of mathematics as objective knowledge, separated from the people who learn and do mathematics, and yet is how the mathematicians she interviewed see their own research, and learning of mathematics.

The didactic, transmission-based teaching that often goes on in mathematics lecture theatres reinforces the students' view that mathematics is a difficult and uninteresting subject that requires rote learning and regurgitation of facts to pass assessments. Dreyfus (1991) noted in particular that if the focus is always on a finished product then the students don't gain insights into the processes that underpin the mathematics and they tend towards surface learning, through reproduction.

There is also a mismatch between the beliefs and behaviour of school leavers and those of research mathematicians, but Perrenet and Taconis (2009) put forward that the difference is mainly in the nature of the type of mathematical problem that they encounter. At school the problems are closed, standard and easy, whereas for research mathematician problems are open, challenging and complex. As students move through their undergraduate degree though, Perrenet and Taconis observed that their problem solving beliefs and behaviour shift towards those of their lecturers.

There are of course also lecturers who do adopt the learning facilitation orientation to their teaching of mathematics. Schoenfeld (1996) discusses his experiences over many years with two different groups of university students, a research group and students on a problem-solving course. He describes how these two groups differ but how his approach with each leads to remarkably similar goals. He argues that by adopting a learning facilitation model of teaching in the problem-solving course he can foster a community of inquiry similar to the one that develops more naturally within the research group. In both cases his goal is to develop a mathematical community where,

> "the students emerge from it with a particular sense of the enterprise and a set of finely tuned problem solving skills". p. 15

Lecturers differ in their styles of teaching, due mainly to differences in their understanding of teaching and learning. This understanding will impact on the way that they interact with their students, and as we have seen, this interaction has an effect on a student's quality of learning. For example, one way a distinction can be made between teaching and learning is the way by which the balance of responsibility for each is defined. Many lecturers feel that they are only responsible for the imparting of information to the students, while it is up to the students to merely take the responsibility for their own learning.

What is interesting to me about Schoenfeld's teaching style is how it seems to blur this traditional strict division between the teacher's and learner's roles. By stimulating discussion amongst his students he is allowing them to adopt different roles within the group, sometimes taking on the teacher's role, sometimes the learner's. He acts as the catalyst to set the process going and interjects only when it

needs to be moved along. This not only has an affect on students' quality of learning, but also on their understanding of teaching and learning. However, this whole area of research is beyond the scope of this study, but worth mentioning, as it is an important factor affecting students' quality of learning.

Entwistle (1998a, 1998b, 2000) also concurred that undergraduates perceive their first year courses by what is presented and how they are delivered, and this has an affect on their approaches to studying, and therefore influences the quality of their learning (e.g. Prosser and Trigwell, 1999). As Entwistle et al (2002) reported,

> "…we see that a sophisticated, integrated conception of teaching with a focus on the conceptual development of the student, leads to teaching and assessment methods that emphasise and support the students' understanding, and so encourage a deep approach to studying (Entwistle & Walker, 2002)." p. 8-9

It was also noted that students' experiences at school would influence their approaches to studying at university. Cook and Leckey (1999) found in a study of first-year students' expectations of life at university, that,

> "the teaching and assessment styles in schools may lend themselves to the development of a set of study skills which persist into university but which are no longer appropriate to the more independent styles of learning expected in a tertiary environment" p. 169

A report on Learning Styles by Coffield et al (2004) highlights the strengths and weaknesses of Entwistle's Approaches and Study Skills Inventory for Students (ASSIST - the most up to date iteration of the original Approaches to Studying questionnaire) and these are summarised

Table 3.2 on the next page.

	Strengths	Weaknesses
General	Model aims to encompass approaches to learning, study strategies, intellectual development skills and attitudes in higher education.	Complexity of the developing model and instruments is not easy for non-specialists to access.
Design of the model	Assesses study/learning orientations, approaches to study and preferences for course organisation and instruction.	There are dangers if the model is used by teachers without in-depth understanding of its underlying implications.
Reliability	Internal and external evaluations suggest satisfactory reliability and internal consistency.	Many of the sub-scales are less reliable. Test–retest reliability not shown.
Validity	Extensive testing by authors of construct validity. Validity of deep, surface and strategic approaches confirmed by external analysis.	Construct and predictive validity have been challenged by external studies Unquestioned preference for deep approaches, but strategic and even surface approaches may be effective in some contexts. Rather weak relationships between approaches and attainment.
Implications for pedagogy	Teachers and learners can share ideas about effective and ineffective strategies for learning. Course teams and managers can use approaches as a basis for redesigning instruction and assessment. Model can inform the redesign of learning milieux within departments and courses.	The scope for manoeuvre in course design is variable outside the relative autonomy of higher education, especially in relation to assessment regimes. There is a large gap between using the instrument and transforming the pedagogic environment. As the terms 'deep' and 'surface' become popular, they become attached to individuals rather than behaviours, against the author's intention.
Evidence of pedagogical impact	Has been influential in training courses and staff development in British universities.	Not tested directly as a basis for pedagogical interventions.
Overall assessment	Potentially useful model and instrument for some post-16 contexts outside the success it has had in higher education, but significant development and testing will be needed.	
Key source	Entwistle 1998	

Table 3.2: Entwistle's Approaches and Study Skills Inventory for Students (ASSIST) (Source: Coffield et al, 2004 p. 25)

Entwistle and colleagues did acknowledge these weaknesses, while continuing to strive to develop the overall conceptual framework. However, there was quite a shift

in approach, in that in 2001 Enwistle et al argued that more qualitative research was needed to counter the way that psychometric measures oversimplify the complexity of studying in different environments. In subsequent research done between 2001 and 2005 by the ESRC funded Enhancing Teaching-Learning Environments in Undergraduate Courses (ETL) project, which focussed on five subject areas, Entwistle (2005) reported in a conference paper,

> "There were more similarities than differences among the subject areas in the factor analyses of the questionnaires but, using the whole set of data, important differences have been emerging that show the importance of treating each subject area as having distinctive teaching methods that reflect the nature of the subject itself. This is hardly a surprising finding, given earlier research into differing academic cultures (Becher & Trowler, 2001), but the strength of the link shown in the ETL project warns against looking for 'one size fits all' developments in university teaching and learning, and suggests how both the language of educational innovation, the concepts used to analyse teaching and learning, as well as the particular form of those innovations, have all to be compatible with the everyday discourse about teaching in the discipline and the ways of thinking and practicing that are most salient for a particular course or course unit." p. 18

In the last decade the debate about the approaches to learning research has continued. The multitude of literature on deep and surface learning continues to have a small but vocal number of sceptics (e.g. Webb, 1997, Malcolm & Zukas, 2001) who criticise it for becoming so popular that it effectively excludes other approaches to teaching and learning.

Researchers have written articles attempting to move the focus of student learning away from deep and surface approaches to learning. For example Mann (2001) put forward the idea of moving towards,

> "a focus on alienated or engaged experiences of learning" p. 8

Haggis (2003) goes much further in her criticism of this whole field of research on approaches to learning. In her article she

> "explores problems with the assumed relationships between 'conceptions of learning', 'perceptions of the learning environment', 'approaches to learning' and 'learning outcomes', and suggests that whilst the model may be successful in creating a generalised description of the 'elite' goals and values of academic culture, it says surprisingly little about the majority of students in a mass system." p. 89

and goes on to argue that,

> "One of the fundamental problems with the view of learning that the model presents is that it removes the individual learner from the richness and complexity of his/her multiple contexts." p. 98

However, this criticism of presenting an over simplified account of a very complex process, highlights just what attracts people to it in the first place, and plenty of research articles continue to be published using these concepts. For example recent studies have investigated correlations between approaches to learning and other factors, e.g. the effect of motivation (Kyndt et al, 2011), self regulation and cognitive strategies (Heikkila & Lonka, 2006) and personality and intelligence (Chamorro-Premuzic & Furnham, 2008) all finding them to be predictors of academic study success.

Undergraduate learning of mathematics

Aside from the mention of the teaching of mathematics at university level in the previous section, so far the research I have looked at on student learning in higher education is mostly generic, in that it doesn't take into account the subject area of the student. Although Ramsden (2005) argued,

> "the context of learning is not defined solely by the type of subject being taught and researched in an academic department. Teaching and assessment procedures vary between different academic units, although the effects of these differences on student learning are poorly understood." p. 199

In the context of this study, and in particular with respect to chapters 4 and 7, it is important to review the literature on the learning of mathematics at undergraduate level, a relatively new but expanding area of research. I therefore now briefly move away from students' approaches and conceptions of learning, and return later in this section to the research in this area specifically with mathematics undergraduates.

During the late 1980s, through to the early 2000s there was a significant decline in the number of students applying to study mathematics at university in the UK, something that various researchers have proposed as being due to less than positive experiences of it at school (e.g. Boaler, 1998, Nardi & Steward, 2003). This has led to an increase in research in the field of teaching and learning of undergraduate mathematics. University mathematics departments responded to this decline in

applicants in various ways, for example: changing the syllabus (Kahn & Hoyles, 1997), development of pedagogical practice (e.g. Alcock & Simpson, 2001, Jaworski, 2002, Burton, 2004), reflection on the aim and nature of the tertiary curriculum (Petocz & Reid, 2005). Over this period there has therefore been much progress made in the attempt to improve the learning experience of those students who do decide to study mathematics at university, from both a cognitive and a socio-affective point of view; Tall (1991) and Holton (2001) provide many such examples. This has gone some way to start to reverse the decline in number of mathematics undergraduates, with a 15% increase in enrolments to mathematics courses in higher education in 2009 on previous years. (Source: More Maths Grads final report http://www.moremathsgrads.org.uk/_db/_documents/MMG_FinalReport.pdf)

Affective factors in Mathematics Education

Much of this research on undergraduate learning of mathematics, although relevant to my study in terms of background and context, is not a primary focus of it. My interest in investigating affective factors that influence mathematics undergraduate performance, led my review of the literature to instead search for previous research in this area. From the 1960s and 1970s onwards two main foci are apparent within the literature on affect in mathematics educational research: mathematics anxiety, and attitude towards mathematics.

The 'anxiety towards mathematics' literature drew on methods and theories in psychology (Reyes, 1984) applied to test anxiety in general. For most researchers the relationship between anxiety and performance was assumed to be negative (Ma, 1999) with the test anxiety inhibiting cognitive processes and leading to reduction in performance. Some considered test anxiety to be the effect of repeated experiences of poor performance. With mathematics anxiety at the "extreme" end of the affective spectrum it was not something I chose to investigate, as I felt it would not be obviously applicable to a group of students who had all chosen to study the subject at degree level. Anxieties they may express have therefore been assumed not to be due to an underlying anxiety with mathematics per se, but that's not to say that test anxiety may still be a contributing factor to academic achievement with some of the students in this study.

In a long needed clarification of theoretical foundations, McLeod (1992) identified three concepts used in the research on affect in mathematics: beliefs, attitudes and emotions. He saw them as ranged along a spectrum of increasing stability and decreasing intensity. Emotions are the most intense / least stable, beliefs the most stable / least intense, and attitudes in between.

However, this is in conflict with the three-component definition of an attitude, well established within social psychology e.g. Triandis (1971), Ajzen (1998), Eagly & Chaiken (1993). Here it is defined as an idea charged with emotion, which predisposes a class of actions to a particular class of social situation, and is made up of three components: cognitive, affective and behavioural. The cognitive component of an attitude is the *idea,* which is generally some category used by humans in thinking, i.e. a person must have concept of the category to be able to have an attitude towards it. The affective component of an attitude is the emotion that charges the idea, i.e. what a person feels when they think about the category. The behavioural component is then a predisposition to action. These three components of attitude interact with each other and tend to become consistent, in that when one changes, it will tend to change the other two.

And herein lies a problem that, despite many attempts by researchers for clarification, there is still little agreement amongst researchers in the field of mathematics education as to a definition of attitude as a construct. As recent as 2009, Di Martino states,

> "Among the affective factors, attitude toward mathematics is one of the most quoted constructs (by researchers in the field, teachers and educational institutions), but this "object" does not seem to have a well-defined and shared meaning. Among studies that explicitly give a definition, we can recognize three main different characterizations of attitude towards mathematics:
>
> a) a "*simple*" definition, that describes attitude as the positive or negative degree of affect associated with mathematics (Haladyna, Shaughnessy & Shaughnessy, 1983, McLeod, 1992);
>
> b) a "*tridimensional*" definition that recognizes three components in attitude: the degree of affect associated with mathematics, the beliefs

> regarding mathematics and the behaviour related to mathematics (Hart, 1989);
>
> c) a "*bidimensional*" definition, that includes only emotions and beliefs and does not consider behaviour (Daskalogianni & Simpson, 2000)." p. 11

Part of the problem, as Kulm (1980) suggests, is that it is almost impossible to define an attitude towards mathematics that is suitable for all situations, and even if one was agreed upon it would probably be too general to be useful. Daskalogianni & Simpson (2000) put forward the notion of the role of a "working definition" of attitude, which is also in line with Ruffell et al (1998) who view attitude as an observer's construct.

Di Martino (2009) goes on to suggest that,

> "From a qualitative analysis of students' description of their relationship with mathematics (Di Martino & Zan, 2010), a multidimensional model for attitude toward mathematics emerges, characterized by three strictly interconnected dimensions: the emotional disposition toward mathematics, the view of mathematics, the perceived competence in mathematics. That suggests the need to overcome the dichotomy between positive/negative attitude, and move to the identification of different profiles of negative attitude." p. 12

While much of this research is focused on students' attitudes to compulsory school mathematics, there is still relevance to university mathematics.

Returning now to prior research in this field, research on attitudes towards mathematics and the relationship with attainment in mathematics has been quite well documented at school level (e.g. Aiken, 1961, Fennema & Sherman, 1976, Ma, 1997, Ma & Kishnor, 1997, Utsumi & Mendes, 2000). Boaler et al. (2000) for example gathered evidence that negative attitudes among high attaining secondary school pupils, especially girls, are often due to unrelenting pressure and pace of coverage. The overall significance of mathematical beliefs and attitudes was highlighted by Wilkins & Ma (2003),

> "a person's mathematical disposition related to her or his beliefs about and attitude towards mathematics may be as important as content knowledge for making informed decisions in terms of willingness to use this knowledge in everyday life." p. 52

Tebbutt's (1993) small scale study showed that sixth form students' perceptions of mathematics and physics, at both A level and in a degree course, is generally unfavourable in comparison to other subjects. These two subjects were perceived as more intellectually demanding, academic, theoretical and, probably most importantly, not interesting, in comparison to other science subjects. What makes these findings worrying, particularly with respect to how interesting the students rated a subject, is that the sample of students were all nearing the end of their A level courses and were all taking either mathematics, physics or both, at this level.

A more recent study by Kitchen (1999) painted a similar picture of students' negative attitudes towards mathematics. It showed that the perceived decline in standards of students' mathematical capabilities by university departments in their entry intake could be explained by three factors; the changing A level cohort, the universities' policy on recruitment, and the fact that able students were choosing not to study mathematical subjects. Many students who did well at GCSE are choosing not to take mathematics A level, and often students with weaker mathematical experience were being recruited instead. The number taking mathematics and further mathematics at A level was also declining, although this trend has now been reversed, and of those less than half went on to study mathematics, physics or engineering at degree level. Kitchen (1999) also found that the relative demands at A level for algebraic fluency had decreased, and that,

> "the amount of pure mathematics content that is compulsory for some modular double mathematics awards is now no more than that of a single mathematics A level." p. 71

However, at the start of this study in 2000, relatively little research had been undertaken into undergraduates' attitudes to mathematics in the UK. A study of motivation among undergraduate mathematics students at Nottingham University by Hall (1982) found that the most common reason students gave for selecting mathematics at degree level was their own ability to do it correctly. The study also showed that the students' motivation in their second year of their course was generally low, perhaps due to the students now starting to doubt their own ability to be successful in their chosen subject.

In 1993, at an undergraduate teaching conference, a working group looked at student's lack of enthusiasm and Burn, Appleby & Maher (1998) later reported,

> "…if their view of mathematics is peculiarly narrow, most of those who sign on to do a degree in mathematics have chosen to do so for the positive reason that they have in some sense enjoyed what mathematics they have done at school. In contrast, few of those who graduate with a degree in mathematics exhibit any desire at all to study the subject further. Most first year mathematics students are willing, or even keen, to find the subject interesting. The potential enthusiasm is soon dissipated." p. 10

Galbraith (1994), in a study with beginning mathematics undergraduates and prospective mathematics teachers (postgraduates) comparing their attitudes to their subject, also concludes that,

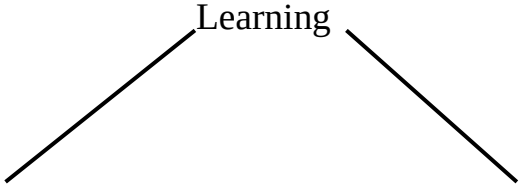
> "mathematics emerges as a subject which progressively loses its appeal with further study." p. 675

The SEUM project (2005) also corroborated these findings, and demonstrated that students' attitudes to mathematics over the course of their degree was not only influenced by their success in the subject, but also that there was a noticeable decline in motivation and commitment to mathematics over this period.

> "When some no longer perceived themselves to be particularly successful, there was little to motivate them to continue studying except a need to maintain self-esteem and gain credentials. By the end of the course, most students did not feel a strong commitment to mathematics. The only ones who described themselves as 'mathematicians' was the small handful considering a lecturing career." p. 3

Students' conceptions of mathematics and approaches to studying mathematics

As discussed already, as well as separating the referential and structural aspects of learning, Marton and Säljö split these down further into their referential and structural components in terms of what is focussed on and how the focus is achieved.



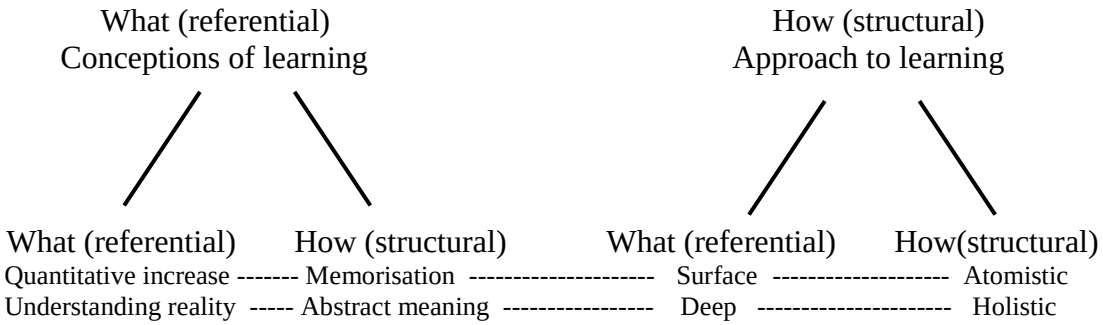


Figure 3.1: Relationship between conception of learning and approach to learning (Source: Crawford et al, 1994, p333)

In a phenomenographic study Crawford et al (1994) synthesised and applied previous generic work in this field e.g. Marton and Säljö, Svensson, Biggs etc, specifically to the learning of mathematics at undergraduate level. They looked at the relationship between the referential and the structural aspects of students learning of mathematics, i.e. students' conceptions of learning mathematics and their approaches to learning mathematics. In this study Crawford et al asked first year mathematics students open-ended questions about their conceptions of mathematics. Their answers were analysed and five categories formed:

Category	Representative quote from student survey
A. Maths is numbers, rules and formulae	*Maths is the study of numbers, and the application of various methods of changing numbers*
B. Maths is numbers, rules and formulae which can be applied to solve problems	*Mathematics is the study of numbers and their application in other subjects and the physical world*
C. Maths is a complex logical system; a way of thinking	*Mathematics is the study of logic. Numbers and symbols are used to study life in a systematic perspective and requires the mind to think in a logical and often precise manner.*
D. Maths is a complex logical system which can be used to solve complex problems	*Maths is an abstract reasoning process which can be utilised to explore and solve problems*
E. Maths is a complex logical system which can be used to solve complex problems and provide new insights used for understanding the world	*Techniques for thinking about observable, physical phenomena in a quantitative way and also for thinking more abstractly with little or no relation to the directly observable universe*

Table 3.3: Categories of Responses for Conceptions of Mathematics (Source: Crawford et al, 1994, p335)

It was noted that there was a qualitative difference between categories A and B, and those of C, D and E. The first two represent a fragmented conception of mathematics as a body of knowledge where the students focussed on 'parts rather than wholes'. The last three categories represent a more cohesive conception of mathematics with the students 'concentrating on the whole picture rather than just the constituent parts'. These five categories were also shown to have a hierarchical, nested relationship.

The students were also asked about their approaches to studying mathematics, and their responses were categorised as follows:

Category	Representative quote from student survey
A. Learning by rote memorisation, with an intention to reproduce knowledge and procedures	*I liked calculus because I could remember formulas which is how I used to study. I would rote learn all the formulas and summarise all my theoretical notes*
B. Learning by doing lots of examples with an intention to reproduce knowledge and procedures	*The way I go about studying for mathematics is by doing a lot of questions and examples. Firstly I would study the notes and learn formulas, then I put all of that to use by doing heaps of exercises*
C. Learning by doing lots of examples with an intention of gaining a relational understanding of the theory and concepts	*To understand a topic well it was important to gain an understanding of the basic concepts involved, backed up by some problem solving on the topic. However, concepts which were not fully comprehended could become well understood through extra work on related questions: i.e. it is essential to do a wide range of questions on a topic to fully understand it*
D. Learning by doing difficult problems, with an intention of gaining a relational understanding of the entire theory, and seeing its relationship with existing knowledge	*After listening to explanations of how a particular maths works the most essential features a repetition to develop speed (this usually consists of boring menial tasks) and an equal component of very difficult problems which require a great deal of thought to explore that area and its various properties and their consequences*
E. Learning with the intention of gaining a relational understanding of the theory and looking for situations where the theory will apply	*Read the relevant theory and try to get on the same "wavelength" as the person who actually discovered it. Before I attempt any problems I try to think where you can use the concept: i.e. what the concept was invented for. Then I attempt problems (on my own)*

Table 3.4: Categories of Responses for Students' Approaches to Learning Mathematics (Source: Crawford et al, 1994, p337)

Again the referential and structural aspects of the students' responses were the basis of the analysis and a shift from surface to deep learning was identified to occur between categories B and C.

Based upon this work Crawford et al (1998a) developed a *Conceptions of Mathematics Questionnaire* (CMQ) and the *Approaches to Learning Mathematics Questionnaire* (ALMQ). The CMQ consisted of a range of statements representing the two broad conceptions of mathematics, cohesive and fragmented. The ALMQ was developed from the 'Study Process Questionnaire', (SPQ) which had been devised by Biggs (1987). This also consisted of a range of statements representing two scales, a deep approach to studying mathematics and a surface approach to studying mathematics.

Crawford et al (1998a) then used these two questionnaires (CMQ and ALMQ) with a group of first year mathematics students. They found that the students' prior conceptions of mathematics were systematically related to the way that they approached the studying of mathematics. In particular they demonstrated that:

> "… on the one hand, that fragmented conceptions of mathematics are associated with surface approaches to learning mathematics, perceptions of assessment as measuring reproduction and perceptions that the workload is too high. On the other hand, cohesive conceptions of mathematics are associated with deep approaches to learning mathematics, perceptions of good teaching and clear subject goals and independent learning." p. 465

The reliability and validity, in terms of internal consistency, of both of these questionnaires has been subsequently assessed in studies outside of Australia which found them to be robust e.g. Alkhateeb (2002, 2003) and Arigbabu & Mji (2005).

One of the points made by Crawford et al (1998a) is that all students enter university with preconceived ideas of the nature of the subject they are going to be studying. This in turn was shown to relate directly to the way in which they approach their studying, and, Crawford et al proposed, the students' quality of learning.

However, research published by Mji (2003) concluded,

> "It has been shown here that despite students' conceptions and orientations to learning mathematics, outcomes depend largely on how they perceive tasks at hand. This suggests that students judge what is happening in their learning context and respond in terms they deem appropriate for the particular task they are handling." p. 696

A study by Kaasila et al (2005) reported on students' socio-emotional orientations, or types of coping, in mathematical learning situations. They classified three different categories in terms of student teachers' *view of mathematics*: task-orientation, socially dependent orientation, and ego-defensive orientation, where they defined a *view of mathematics* as a concept comprising of a person's knowledge, beliefs, conceptions, attitudes and emotions.

Task orientation or task-oriented coping is dominated by an intrinsically motivated tendency to approach, explore and master the challenging aspects of the environment. The student's initial cognitive appraisal of task cues and instructions consists of recognising the task as intelligible. Emotions like curiosity, interest or enthusiasm arise.

In *social-dependence orientation* student adaptation to the learning situations is dominated by social motives, such as seeking help and affiliation from the authority. The student is not very willing to make self-directed and independent efforts, she/he easily become helpless and seeks hints and support from others. The students' expectations of success are high and are not related to self-contained task control but instead to getting the teacher's help. Positive emotions are connected with expected satisfaction of the teacher, and students are not ready to proceed independently.

Ego-defensive oriented student adaptation is dominated by self-defence and self-protective motives. The student will be sensitised to task difficulty cues and signs anticipating a negative response from the teacher. He or she does not concentrate intensively on the task at hand, and may try to find some compensatory tactics in order not to "lose face". The student's expectations of success are low.

These relate in many ways to Ramsden & Enwistle's (1983) meaning, reproducing and achieving orientations to learning. Certainly the task orientation Kaasila et al suggest is very akin to the meaning orientation put forward by Ramsden & Entwistle (1983). The social-dependence orientation has aspects of the reproducing orientation (e.g. relying on staff to define learning tasks), whereas the ego-defensive orientation has a combination of some of the aspects of reproducing (fear of failure) and some of achieving orientation (strategic approach).

A study by Reid et al (2003) suggested that students experience mathematics in three qualitatively different ways. These were labelled components, modelling and life. Components was suggested to be the narrowest view of mathematics where students focus their attention on disparate mathematical activities or aspects of mathematics. Modelling was seen as a broader view of mathematics where students see mathematics as being about building and using models. The broadest view was labelled life, where students view mathematics as an approach to life and a way of thinking. Similar to Crawford et al, they used a phenomenographic analysis of in-depth interviews with 22 students to identify these three hierarchical and inclusive categories. The interviews focussed on the students' experience of learning mathematics, their understanding of mathematics as a discipline field, and their perception of work as a mathematician.

In 2005 Reid et al reported on further work, using the same set of interviews, also aiming to build on and expand earlier descriptions of students' learning approaches, and presented a theoretical model based on their research findings. In this paper they describe and investigate three aspects of learning mathematics: intention, approach and outcome, which emerged from these student interviews, and established that there was a consistency between students' intentions for learning mathematics and the outcomes of their studying. This is akin to the work by Crawford et al (1998a) that proposed the relationship between the way students approach their learning of mathematics and the quality of their learning.

Reid et al extended their work on students' conceptions of mathematics, by undertaking an international study of almost 1,200 undergraduates in five countries, see Petocz et al (2007), and again in Houston et al (2010). Petocz et al (2007) reported that,

> "Students' conceptions of mathematics ranged from the narrowest view as a focus on calculations with numbers, through a notion of mathematics as a focus on models or abstract structures, to the broadest view of mathematics as an approach to life and a way of thinking." p. 439

This study again helped to confirm the hierarchical nature of students' conceptions of mathematics, as put forward in the research by Crawford et al (1994), and also expanded on their previous three qualitatively different ways of experiencing

mathematics, to now five conceptions of mathematics: *number*, *components*, *modelling*, *abstract*, and *life.* They also found that students' conceptions of mathematics tended to be broader later in their degree course.

> "Broader conceptions of mathematics were more likely to be found in later-year students (p<0.001) and there were significant differences between universities (p<0.001)." p. 439

However, despite this strong indication of a higher proportion of students with broader conceptions of mathematics in later years of study, they did also acknowledge,

> "Of course, as this was not a longitudinal study, we cannot conclude that individual students are broadening their conceptions." p. 455

Evidence of the potential for development of students' conceptions over the period of a degree course, was also put forward by Morgan and Beaty (2005), but in that case it was with respect to Open University students' conceptions of learning in general, rather than conceptions of mathematics as a subject.

Conclusions

Recall that my overall research question is: How do mathematics undergraduates' experiences and attitudes change during their course? Addressing this my initial plan was to investigate this cohort of undergraduate students' experiences, and attitudes towards mathematics by examining their approaches to studying, and conceptions of, mathematics, what they liked / disliked about it as a subject, and how much they participated in their subject, in terms of attendance, coursework, reading round their subject.

However, precisely defining the construct "attitude" was beyond the scope of this thesis, even just within the context of this study. Bearing this original plan for data collection in mind, I decided to adopt the tridimensional definition of attitude to mathematics put forward by Triandis (1971), Ajzen (1998), Hart (1989), Eagly & Chaiken (1993), and therefore encompass emotional, cognitive and behavioural aspects, and then to continually bear them in mind while investigating the experiences of this particular group of students. The longitudinal aspect to this study

was key, so these components were to be looked at throughout the three years of the students' course.

Back in 2000, at the start of this study, I chose to use the ALMQ and the CMQ mainly because, having used them before, I felt that they would help me develop an overview of this cohort of students, which in turn would provide some context for the case studies of those students interviewed. I also wanted to investigate new ideas within this area of research, especially whether they could contribute in terms of a longitudinal perspective on undergraduates' approaches and conceptions of mathematics, and this led me to my first subsidiary research question that will be the focus of the next chapter: How do these students' approaches to studying, and conceptions of, mathematics, relate to each other; change over time; and relate to the students' examination results?

In hindsight, despite the weaknesses of this type of questionnaire suffer from, e.g. the subjectivity of likert scales in that one person's "agree" is someone else's "strongly agree", participants tending to respond towards the middle of the scale, and participants providing answers that they feel they should rather than what they truly believe, I still feel that it provided me with a good starting point by which to investigate this cohort of students, and was helpful in terms of context for the study. As will be seen in the next chapter, it also led me to ask particular questions when analysing the interview data. However, I have the same reservations on the use of this type of questionnaire in isolation, as referred to by other researchers e.g. Webb, 1997, Malcolm & Zukas, 2001, Haggis (2003).

In fact, as will also be seen in the next chapter, my results from analysing the data from these questionnaires presented me with yet more questions, as they did not replicate the results of other researchers, nor, in the case of the longitudinal aspect of repeated use of the questionnaires, did they produce results that had been anticipated.

Chapter 4: Approaches to studying, and conceptions of, mathematics

Introduction

In this chapter I outline the data analysis resulting from the *Approaches to Learning Mathematics*, and *Conceptions of Mathematics* questionnaires. These questionnaires were combined into one document, and administered twice to the cohort of students during their degree, once near the beginning of their first year, and then again nearing the end of their third year. This not only provided snapshots of the cohort overall, but enabled me to compare the two responses of individual students over this time frame.

I start this chapter by restating my main research question, and setting out the subsidiary aims focussed on here. I elaborate on details of the questionnaire first presented in Chapter 2 by giving a fuller explanation as to the inherent scales, their usage and the abbreviations adopted for the rest of the chapter. I then briefly present my quantitative results for the cohort, including comparisons of the scales for each time the questionnaire was administered, as well as comparisons between the two data sets, before turning my attention to four individual students in the form of case studies. These four case studies take into account both quantitative data from their questionnaire results, and qualitative data from their interview transcripts.

Research Questions

As stated in Chapter 1, my research question underpinning this study is: How do mathematics undergraduates' experiences and attitudes change during their course? This section of my thesis will contribute towards this overall question by focussing on answering the question: How do these students' approaches to studying, and conceptions of, mathematics, relate to each other; change over time; and relate to the students' examination results?

I do this by considering in turn, five subsidiary aims within this overall question, namely:

i. How do these students' approaches to studying mathematics relate to their conceptions of mathematics?
ii. What effect do gender and age have on these students' approaches to studying mathematics, and conceptions of mathematics?

At the time, no previous research had used these questionnaires in a longitudinal study to see if students' approaches and conceptions of mathematics changed over time. A criticism of these types of questionnaires is that they provide merely a snapshot of students at a particular point in time. By taking two such snap-shots, using the questionnaires at the beginning and end of their degree, it was hoped to answer the research question:

iii. Did these students' approaches to studying mathematics and conceptions of mathematics change over the three years of their degree? And, if so, how?

Also, when this study began in 2000, previous research had claimed a link between students' approaches to studying, conceptions of mathematics, and examination marks (Crawford et al, 1998a). Therefore my next research question:

iv. How do this cohort of students' approaches to studying of mathematics, and conceptions of mathematics relate to their exam results?

The results of this comparison soon led to my final research question, of this chapter:

v. How did contextual factors impact on these students' approaches to studying mathematics and conceptions of mathematics?

The Questionnaire: Approaches to Learning, and Conceptions of, Mathematics

The design of the questionnaire used has already been briefly described in Chapter 2, but I repeat and elaborate on it here for continuity and ease of reading. It was made up of two separate questionnaires taken from previous established research: The *Approaches to Learning Mathematics Questionnaire* (ALMQ) and the *Conceptions of Mathematics Questionnaire* (CMQ). These were both developed by Crawford et al (1998), the first from the *Study Process Questionnaire* (SPQ) (Biggs, 1987) and the second from their own previous phenomenographic study (1994). However, I give below a full explanation as to my choice of the scales, in terms of the terminology used.

The items in the original SPQ refer to approaches to study in general, and these were modified by Crawford et al to refer to students' approaches to learning mathematics. The two scales applied in both these questionnaires are the surface approach and the deep approach to learning within an academic task. Although these terms are used frequently in the literature on students' learning I chose to adopt the terms meaning and reproducing orientations as the two scales for investigation within this section of my questionnaire, as explained below.

The *Approaches to Study Questionnaire* (ASQ) was developed by Richardson (1990) from Enwistle and Ramsden's original questionnaire (1983) of the same name. The two main scales used in the ASQ are meaning and reproducing, and although different versions of the ASQ have also identified other orientations, e.g. Entwistle & Ramsden (1983), Lonka & Lindblom-Ylaine (1996), these results have not been consistently replicated. Meaning and reproducing orientations encompass deep and surface approaches respectively as sub-scales. A meaning orientation also includes conceptual dimensions intrinsic motivation, and relating ideas, and a reproducing orientation also includes syllabus boundness, disorganized studying, and fear of failure. These more generic constructs, meaning orientation and reproducing orientation, therefore cover broader aspects of the students' approaches to studying than those of just deep and surface learning. I felt that some of the statements used in the ALMQ did cover these broader aspects of the students' approaches to learning

mathematics as described by the other sub-scales within the meaning and reproducing orientations (see Table 3.1 for the full list). Also, since these two scales were the only ones to achieve satisfactory levels of reliability (Richardson, 1990), I decided that these broader descriptors of the process, were more encompassing than the deep and surface approaches used by Crawford et al (1998) when presenting my results.

For the CMQ (Crawford et al, 1998) section of my questionnaire I chose to stick with the fragmented and cohesive conceptions of mathematics as referred to in the original paper as the two scales to investigate.

Therefore the four scales under investigation, and the abbreviations used for them throughout the rest of the study are:

- Mathematics Meaning orientation (MM1 and MM2)
- Mathematics Reproducing orientation (MR1 and MR2)
- Cohesive Mathematics Conceptions (CMC1 and CMC2)
- Fragmented Mathematics Conceptions (FMC1 and FMC2).

where, for example, MM1 is the mathematics meaning orientation scale for the first time the questionnaire was administered and MM2 for the second time. Any statistically significant results found from these tests for correlation on the pairs of scales imply that there is the likelihood of a relationship between them. However, it must be noted that this relationship is not assumed to be causal.

It must be emphasised here that these two pairs of scales are not opposing ends of two spectrums. In other words, the terms meaning and reproducing do not represent either end of a spectrum of orientations towards studying, they are two separate scales. Individual students have a combination of the different aspects of both the meaning and reproducing orientation to learning mathematics In terms of meaning and reproducing orientations they represent two of the four approaches to studying scales identified by Ramsden and Enwistle (1983), but the only ones to be replicated with satisfactory levels of reliability by Richardson (1990).

Neither do the terms cohesive and fragmented represent either end of a spectrum of conceptions of mathematics. However, it can be seen from the hierarchical nature of the five conceptions of mathematics, as defined by Crawford et al (1994), that these two scales are related, in that those students who have more cohesive conceptions of mathematics are less likely to have fragmented conceptions. However, it is still possible for students to have a combination of both.

Statistical Analysis of Questionnaires B and D

These two questionnaires were essentially the same one administered twice with the students, and can be found in Appendix II and Appendix IV. It uses a five point Likert scale, allowing the students to respond by ticking the appropriate box to indicate whether they strongly agreed, agreed, were neutral / didn't know, disagreed, or strongly disagreed with each of the statements. These responses were subsequently allocated numbers 5 to 1 respectively for the analysis of the data. Four separate scales are used within the questionnaire, meaning and reproducing orientation to learning mathematics, and cohesive and fragmented conceptions of mathematics. Each of these scales is represented by a group of statements that are randomly distributed through the list, and depending on how strongly the student chooses to agree or disagree with each statement will generate an overall score for each of the four scales.

To avoid the issue of whether the data sets follow an underlying normal distribution or not, non-parametric tests were used to analyse all the quantitative data. The tests used were Spearman's rho (rank order correlation coefficient), the Wilcoxon Mann-Whitney test (also called Wilcoxon's rank sum test), and the Wilcoxon signed ranks test. All of these tests are performed on the ranks of the scores rather than the raw scores.

Non-parametric tests, although generally less powerful than parametric tests, are less likely to mislead since they are not dependant on distributional assumptions. They are also suited to small sample sizes, which was particularly useful considering the low completion rate of the questionnaire the second time it was administered. Rank

tests are also helpful if outliers are present in the data set, as the ranks of raw scores in effect eliminate any extreme values (Peers, 1996).

Spearman's rho was used to test for any significant relationships between pairs of scales. The scales were the meaning and reproducing orientations for their studying of mathematics, and their cohesive and fragmented conceptions of mathematics, both in Year 1 and Year 3. However with this many scales the number of resultant pairs tested would inevitably produce one or two spurious results. The decision was therefore made to only compare the following pairs of scales for each time the questionnaire was administered:

- Meaning and cohesive
- Meaning and fragmented
- Reproducing and cohesive
- Reproducing and fragmented

to reduce the likelihood of spurious results. The null hypothesis in each case is that there is no association between the two variables and the alternative hypothesis is that there was an association. This two-tailed alternative hypothesis was adopted as no assumption was being made as to whether an association would be positive or negative.

The Mann-Whitney test was used to investigate any differences amongst the cohort in terms of age and gender, primarily the first time the questionnaire was administered. The null hypotheses being that there is no difference for age or gender, and the alternative hypotheses being that there is a difference for these factors.

The Wilcoxon signed ranks test was used to test for differences between the two times the questionnaire was administered in Year 1 and Year 3. The null hypothesis being tested was that these two samples were from one population, i.e. there is no difference in the rank order values in the two groups. The alternative hypothesis was that the two sample distributions of rank scores are different, again a two-tailed, non-directional test. This produced four tests.

All of the tests described were originally carried out on the data using the statistical software package SPSS version 12.0.1 but some of the correlations were also

rechecked using the Pearson product-moment coefficient within Excel for Mac 2008, and their significance levels using software found at http://faculty.vassar.edu/lowry/ch4apx.html (retrieved June 2011).

Findings from Questionnaires B and D

I start by looking at the two times the questionnaire was administered separately to see whether my data fit with previous research findings. I then look at gender and age differences for these scales within the cohort, and compare the students' examination results to their approaches to, and conceptions of, mathematics. Finally, I investigate whether there are any differences between the first and second time the questionnaire was administered by looking at each of the four scales to see if the students' approaches and or conceptions changed over the period of their degree.

The results of all of these statistical tests are presented and briefly summarised and discussed, without a particularly in depth exploration of the data. This is due in main to the change of emphasis of this chapter, and the study overall as it has developed, away from a quantitative analysis towards a more qualitative one. Therefore although I felt it important to include the results from these questionnaires to investigate trends within the cohort, the interview data and individual experiences of the some the students proved to provide a much richer account, and that is where I shifted my focus in terms of reporting, to help explain the results from my analysis that differed from prior research.

As already mentioned, Appendices II and IV show the questionnaire that the students completed. As can be seen a Likert sliding scale is used by the respondent to answer each question, by choosing one of the terms "strongly agree", "agree, "neutral", "disagree" and "strongly disagree". These terms were then designated a rank score of 1 to 5, with 5 being "strongly agree" and 1 being "strongly disagree". In this questionnaire, statements: 1, 2, 4, 6, 8, 12, 14, 16, 20, 22, 24, 25, 26 are representative of a meaning orientation towards studying mathematics, and statements: 3, 5, 7, 9, 10, 11, 13, 15, 17, 18, 19, 21, 23 are representative of a reproducing orientation towards studying mathematics. Similarly statements: 29, 32, 34, 36, 37, 40, 41, 43, 45 are representative of having cohesive conceptions of

mathematics and statements: 27, 28, 30, 31, 35, 38, 39, 42, 44 fragmented conceptions.

A claim made in previous studies (e.g. Crawford et al, 1998a; Reid et al, 2005) is that the ideal is that students adopt an overall meaning orientation to their studying and have cohesive conceptions of mathematics. Ideally they would therefore be attaining a high total score for the statements relating to these. Conversely the students should also ideally attain low total scores for the statements relating to reproducing orientations and fragmented conceptions of mathematics.

This stated 'ideal' is not meant to imply that there are not instances when a reproducing orientation to studying is a good approach for a student to adopt, but overall students should be encouraged by the teaching and assessment methods used, to take a more meaning orientation. Neither is it intended to imply that these two study orientations are opposing ends of a continuous scale. As already stated they are in fact two separate scales, and any individual student will, at any one time, and for any particular context have components of both orientations.

	Number of completed questionnaires	**Range of possible total scores**	**Minimum total score observed**	**Maximum total score Observed**	**Mean total score**	**Std. Dev.**
MM1	103	13 – 65	29	63	43.18	6.38
MM2	29	13 – 65	24	56	43.86	7.56
MR1	103	13 – 65	25	60	43.40	7.60
MR2	29	13 – 65	19	62	43.45	9.90
CMC1	102	9 – 45	16	45	33.14	6.24
CMC2	29	9 – 45	13	44	32.72	7.63
FMC1	102	10 – 50	10	46	28.96	7.03
FMC2	29	10 – 50	14	40	26.69	6.70
Valid N (listwise)	28					

Table 4.1: Descriptive statistics of the four scales for both times the questionnaire was administered. Total scores are used here.

The descriptive statistics for both times the questionnaire was administered are presented in table 4.1, and boxplots in Figures 4.1 and 4.2. As can be seen, the students' total scores covered much of the range of possible total scores for each of the scales i.e. the number of questions for each scale, multiplied by the maximum and minimum score possible for each question, ranging from 1 to 5. This was true even the second time the questionnaire was administered, when the number of completed questionnaires was small (N=29). The reasons for the relatively low percentage (32%) of respondents the second time the questionnaire was administered have already been noted in Chapter 2, but the possible impact of this poor completion rate will be discussed later in this chapter.

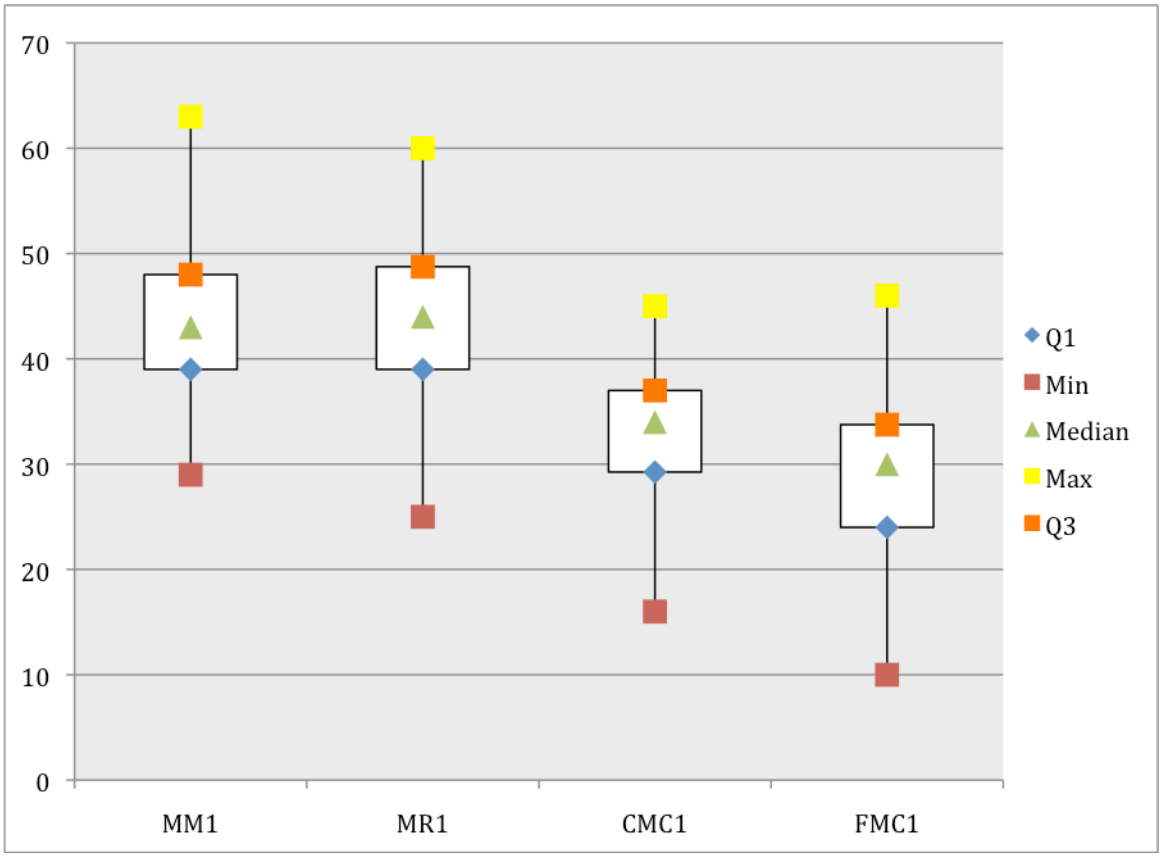


Figure 4.1: Boxplots of the four scales the first time the questionnaire was administered. Total scores are used here.

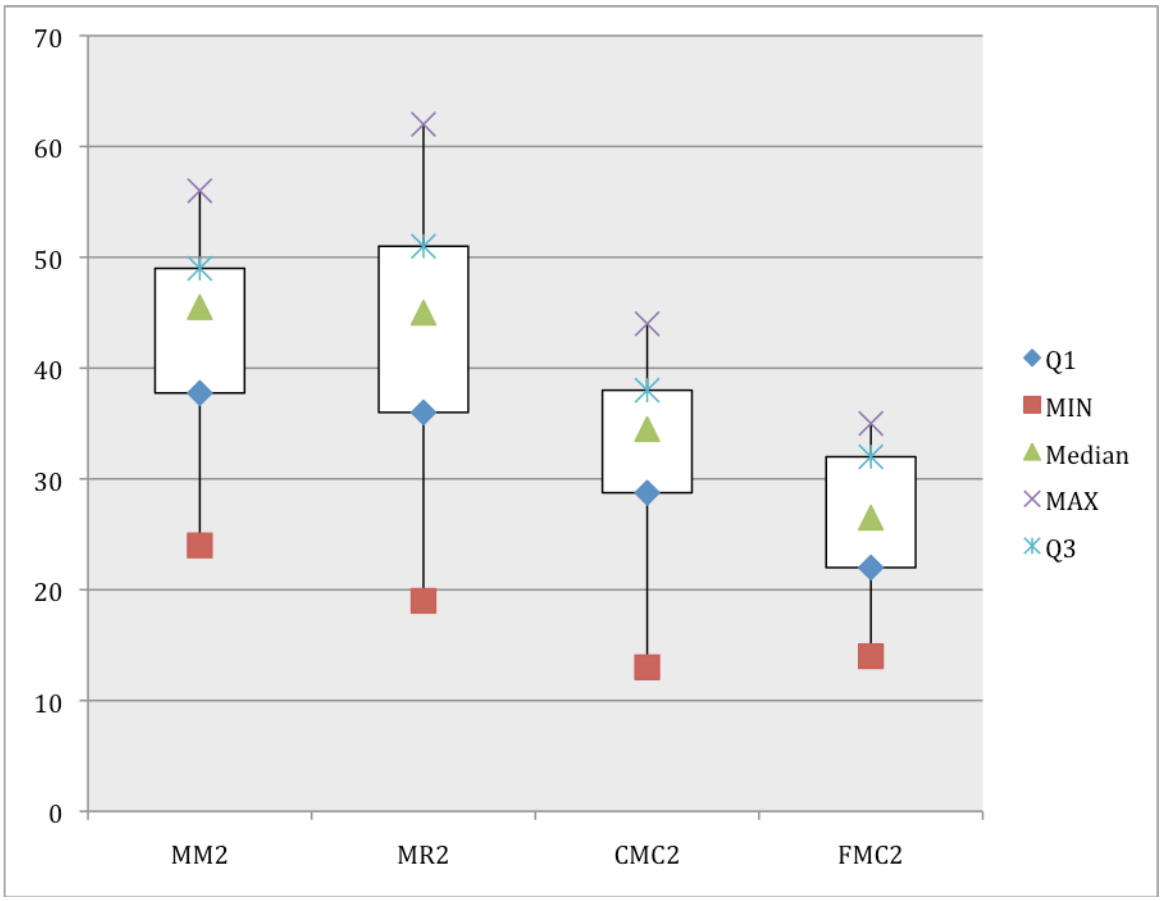


Figure 4.2: Boxplots of the four scales the second time the questionnaire was administered. Total scores are used here.

I return now to the subsidiary research aims as set out earlier in this chapter, and investigate the first four by analysing the data from the questionnaires, before looking at four case study students to help address the fifth and final research aim of this chapter, as well as explain the results further.

i. How do these students' approaches to studying mathematics relate to their conceptions of mathematics?

Using Spearman's rank correlation test the difference between the four scales was investigated for both the first and second questionnaire separately. As previously mentioned, non-parametric tests were used throughout this chapter to analyse all the quantitative data. This was to done avoid the issue of whether the data sets follow an underlying normal distribution or not. Since no assumption was made as to whether any correlation found would be positive or negative a 2-tailed test was used. Tables 4.2 and 4.3 show the results of these tests. The upper of the two values is the

correlation coefficient ‘r’ (to 3 decimal places), and the one below is the level of significance (to 3 decimal places).

Comparison of the four scales, for both times the questionnaire was administered, clearly shows that the data fits with findings from previous research e.g. Crawford et al (1998a), in that those students who adopt a meaning approach to studying mathematics are more likely to have cohesive conceptions of mathematics, and those that adopt a more reproducing approach to studying mathematics are more likely to have fragmented conceptions of mathematics. Scatter plots of this data can also be found in Appendix VII.

	MM1	**MR1**
CMC1	**0.394****	0.079
	0.000	*0.430*
FMC1	-0.019	**0.365****
	0.847	***0.000***

** Correlation is significant at the 0.01 level (2-tailed)

Table 4.2: Spearman rank correlation coefficients and the 2-tailed significance (in italics) for the four scales for the first time the questionnaire was administered (N=102)

	MM2	**MR2**
CMC2	**0.681****	0.344
	0.000	*0.068*
FMC2	0.125	**0.439***
	0.517	***0.017***

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 4.3: Spearman rank correlation coefficients and the 2-tailed significance (in italics) for the four scales for the second time the questionnaire was administered (N=29)

I also include, in Table 4.4 on the next page, a comparison of the four variables the first time this questionnaire was administered (i.e. MM1, MR1, CMC1, FMC1) but just for the 28 students who completed the questionnaire twice. This allows the reader a direct comparison between the two times the questionnaire was administered for this particular sample. Once again the same significant results were found.

	MM1	MR1
CMC1	**0.566****	0.002
	0.002	*0.992*
FMC1	0.169	**0.416***
	0.392	***0.028***

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 4.4: Spearman rank correlation coefficients and the 2-tailed significance (in italics) for the four scales for the first time the questionnaire was administered, but only for the 28 students who completed both questionnaires (N=28)

In addition t-tests were performed to check whether the 28 students who completed both questionnaires were representative of the entire cohort of 102 students. These statistical tests compared the 28 students against the other 74 students who only completed the first questionnaire. No assumption was made as to which group might have higher scores and therefore 2-tail t-tests was performed. For all four variables on the first questionnaire i.e. MM1, MR1, CMC1 and FMC1 there was no significant difference found between these unpaired groups. It was therefore assumed that these 28 students were representative of the cohort, at least in terms of the four variables under investigation.

ii. What effect do gender and age have on these students' approaches to studying mathematics, and conceptions of mathematics?

The Mann-Whitney test was used to investigate whether there was any difference in the four scales for age amongst the cohort. Here I have classified "traditional" students as being age 18-20, and "mature" students are age 21 or over. Only the data from the first time the questionnaire was administered was tested, as the second time round only 2 mature students completed the questionnaire. Please also note that only 93 students included their age on the questionnaire.

Looking for any difference in the four scales in terms of students' age, only one significant difference was discovered, which was that the mature students were more likely to have adopted a meaning approach to studying than their "traditional" counterparts, as can be seen in Table 4.4. This is in agreement with previous research findings (Richardson (1994, 1995) and Magee et al (1998)). It is also worth noting

though that although not statistically significant at the 0.05 level the mature students also tended towards having a less reproducing approach to studying (significance level = 0.084) and were less likely to have fragmented conceptions of mathematics (significance level = 0.064).

Ranks

	Age	N	Mean Rank	Sum of Ranks
MM1	**Traditional**	87	45.37	3947.00
	Mature	6	70.67	424.00
	Total	93		
MR1	**Traditional**	87	48.27	4199.50
	Mature	6	28.58	171.50
	Total	93		
CMC1	**Traditional**	86	45.62	3923.00
	Mature	6	59.17	355.00
	Total	92		
FMC1	**Traditional**	86	47.86	4116.00
	Mature	6	27.00	162.00
	Total	92		

Test Statistics

	MM1	MR1	CMC1	FMC1
Mann-Whitney U	119.00	150.50	182.00	141.00
Wilcoxon W	3947.00	171.50	3923.00	162.00
Z	-2.224	-1.731	-1.203	-1.853
Asymp Sig (2-tailed)	**0.026***	*0.084*	*0.229*	*0.064*

* Significant difference at the 0.05 level (2-tailed)

Table 4.5: Differences in terms of age for the four scales the first time the questionnaire was administered

Differences for gender were also investigated, but no significant differences were found either time the questionnaire was administered, as can be seen in Table 4.6 (which spans the next two pages). This is also in agreement with previous research (especially Anthony (2000) who investigated factors influencing first-year students' success in mathematics). However, it was noted that the first time the questionnaire

was completed the female students tended towards taking a more reproducing approach to their studying than their male counterparts (significance level = 0.077).

Ranks

	Age	N	Mean Rank	Sum of Ranks
MM1	**Male**	67	52.38	3509.50
	Female	36	51.29	1846.50
	Total	102		
MR1	**Male**	67	48.19	3229.00
	Female	36	59.08	2127.00
	Total	102		
CMC1	**Male**	66	50.53	3335.00
	Female	36	53.28	1918.00
	Total	102		
FMC1	**Male**	66	49.98	3298.50
	Female	36	54.29	1954.50
	Total	102		
MM2	**Male**	17	16.21	275.50
	Female	12	13.29	159.50
	Total	29		
MR2	**Male**	17	13.15	223.50
	Female	12	17.63	211.50
	Total	29		
CMC2	**Male**	17	16.03	272.50
	Female	12	13.54	162.50
	Total	29		
FMC2	**Male**	17	14.91	253.50
	Female	12	15.13	181.50
	Total	29		

Test Statistics

	MM1	MR1	CMC1	FMC1
Mann-Whitney U	1180.50	951.00	1124.00	1087.50
Wilcoxon W	1846.50	3229.00	3335.00	3298.50
Z	-0.177	-1.766	-0.449	-0.705
Asymp Sig (2-tailed)	*0.860*	*0.077*	*0.654*	*0.481*

	MM2	MR2	CMC2	FMC2
Mann-Whitney U	81.50	70.50	84.50	100.50
Wilcoxon W	159.50	223.50	162.50	253.50
Z	-0.910	-1.397	-0.776	-0.067
Asymp Sig (2-tailed)	*0.363*	*0.166*	*0.438*	*0.947*

Table 4.6: Difference in terms of gender for the four scales, both times the questionnaire was administered

iii. Did these students' approaches to studying mathematics and conceptions of mathematics change over the three years of their degree? And, if so, how?

To look for changes in approaches to studying and conceptions of mathematics between the two times the questionnaire was administered, the Wilcoxon signed ranks test was used to investigate differences between each of the four scales. A direct comparison of the four scales for each time the questionnaire was undertaken, i.e. MM1 to MM2, MR1 to MR2, etc, showed no significant differences. Table 4.7 on the next page shows the results of Wilcoxon Signed Ranks test.

Ranks

		N	Mean Rank	Sum of Ranks
MM2 – MM1	**Negative Ranks**	12	15.00	180.00
	Positive Ranks	13	11.15	145.00
	Ties	3		
	Total	28		
MR2 – MR1	**Negative Ranks**	11	12.36	136.00
	Positive Ranks	15	14.33	215.00
	Ties	2		
	Total	28		
CMC2 – CMC1	**Negative Ranks**	14	11.75	164.5
	Positive Ranks	11	14.59	160.5
	Ties	3		
	Total	28		
FMC2 – FMC1	**Negative Ranks**	11	17.14	188.50
	Positive Ranks	14	9.75	136.50
	Ties	3		
	Total	28		

Test Statistics

	MM2-MM1	MR2-MR1	CMC2-CMC	FMC2-FMC1
Z	-0.471	-1.005	-0.054	-0.703
Asymp Sig (2-tailed)	*0.637*	*0.315*	*0.957*	*0.482*

Table 4.7: Ranks and test statistics for comparison of scales for Questionnaires B and D

As can be seen no significant differences were found between the two times the questionnaire was administered, for all four scales under investigation. Also, as already noted the sample size for those students completing the questionnaire both times was quite small (N=28) but looking at the descriptive statistics in Table 4.8 (on the next page) it can be seen that there is very little variation between the scales' means and standard deviations, between the two times the questionnaire was administered.

	Mean total score	Std. Dev.
MM1	43.18	6.375
MM2	43.86	7.558
MR1	43.40	7.597
MR2	43.45	9.902
CMC1	33.14	6.235
CMC2	32.72	7.629
FMC1	28.96	7.034
FMC2	26.69	6.698

Table 4.8: Means and standard deviations for each of the scales under investigation

As far as I'm aware no other study has compared a cohort of undergraduate mathematics honours students' approaches to studying, or conceptions of, mathematics over the period of their degree. From my results it can be argued that, for this sub-group of 28 students at least, their approaches to studying mathematics did not change significantly between the two times the questionnaire was administered. When they started their first year they adopted particular approaches to their studying (be they more meaning or more reproducing) and the teaching and learning experience the students encountered did not significantly affect these. With previous studies both reporting it desirable that students take more of a meaning, and less of a reproducing approach to their studies (e.g. Biggs, 1987, Entwistle & Ramsden, 1983), and that this can be affected by the teaching and assessment methods used (Dreyfus, 1991) it was disappointing to find no evidence of significant changes in this direction over the three years.

A study by Petocz et al (2007) looked at undergraduates, of various mathematical degree subjects in several universities, in each of the three years of study and concluded that,

> "While our results show that there is a pleasing increase in the proportion of students who have broader conceptions of mathematics in later years of study, the full range of variation is present in classes at all levels: it is simply not true that all students enter university with the narrowest ideas about mathematics and leave with the broadest ideas." p. 455

As previously mentioned, the Petocz et al (2007) study was not a longitudinal one so no conclusions can be drawn as to whether students' conceptions of mathematics

become broader during their time at university, or whether their result was due to a difference between these particular year groups. However, they did also find that,

> "… more than half of students, some in their final year of study, consider mathematics only as isolated techniques (the Number and Components conceptions)." Petocz (2007) p. 456

As with any undergraduate first year cohort, the conceptions of mathematics of the students in my study varied considerably at the start of their degree, and covered the full range of categories that have been defined in previous research studies, be that the cohesive and fragmented scales of Crawford et al (1998a), or the five categories defined by Petocz et al (2007). With these categories being hierarchical it was anticipated that there would be a shift towards more students having broader, or more cohesive conceptions of mathematics by the time they completed their degree course. However this did not appear to happen for these 28 students who completed the questionnaire twice. Their conceptions of mathematics did not change over the period and so appeared not to have been affected by their experiences within this department.

These results seem to paint a simplistic view of a very complicated process, especially when considering the students involved at an individual level. They are therefore discussed again in more detail, later in the chapter when interview data from four of the students is analysed. As Entwistle et al (2002) acknowledge,

> "..we are becoming more and more aware of the difficulty, through any single conceptual framework, of adequately representing the complexity and the social dynamics of the inter-relationships that exist in everyday teaching and learning." p. 16

iv How do this cohort of students' approaches to studying of mathematics, and conceptions of mathematics relate to their exam results?

Previous research (e.g. Crawford et al, 1998a, Entwistle, 2000) found that a more meaning approach to learning is linked to better examinations results, and a more reproducing one to worse examination results, so comparisons were next made between each of the four scales and examination results for this cohort.

Firstly, no significant correlations were found to be present between any of the four scales for the first time the questionnaire was administered, and the students' exams

results at the end of Year 1, at least for the 97 students who I had both questionnaire and exam data. However, what was shown to have a small, but significant, negative correlation was the relationship between these students' results in their mid-sessional tests (taken half way through their first year, but not counting towards their degree) and their fragmented conceptions of mathematics – see Table 4.9.

	Exam Year 1	**Mid-sessional test**
MM1	0.026 *0.799*	0.088 *0.390*
MR1	-0.042 *0.679*	-0.099 *0.336*
CMC1	-0.038 *0.714*	0.040 *0.698*
FMC1	-0.036 *0.727*	**-0.229*** ***0.025***

* Correlation is significant at the 0.05 level (2-tailed)

Table 4.9: Spearman rank correlation coefficients and the 2-tailed significance (in italics) for the comparison of the four scales and exam/test results for the first time the questionnaire was administered (N=97)

Next a comparison was made between the four scales, for the second time the questionnaire was administered, and the students' third year exam results. Again no significant correlations were found.

A comparison of the exam results for each year however (including the first year mid-sessional test results) showed that there are strong positive correlations between them all, i.e. students who went on to complete their degree during the usual three year time frame tended to have consistent exam results year on year. This data is presented in Table 4.10.

Those who did well in the mid-sessional tests, also did so in the first, second and third year exams, and similarly for those who did not do so well, and continued for all three years. It is also noted that very few students dropped out in the second or third year of the study (three students failed their second year exams and did not continue into the third year, and two students failed after completing all three years

of study). This suggests that there is more to investigate in particular in relation to what happens during the students' first year.

	Mid-sessional Tests Year 1	Year 1 Exams	Year 2 Exams	Year 3 Exams	Final Degree result
Mid-sessional Tests Year 1	1.00	**0.748**** ***0.000***	**0.502**** ***0.000***	**0.531**** ***0.000***	**0.585** ***0.000***
Year 1 Exams		1.00	**0.701**** ***0.000***	**0.668**** ***0.000***	**0.771**** ***0.000***
Year 2 Exams			1.00	**0.776**** ***0.000***	**0.906**** ***0.000***
Year 3 Exams				1.00	**0.948**** ***0.000***
Final Degree result					1.00

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 4.10: Spearman rank correlation coefficients and the 2-tailed significance (in italics) for the comparison of year on year examination results

As was noted in Table 4.8, the mid-sessional test results were negatively correlated to the students' fragmented conceptions of mathematics, this would imply that the worse a student does in these tests the more likely they are to have fragmented conceptions of mathematics. This finding seemed worth pursuing further, therefore the Mann-Whitney test was used to consider whether there was any difference in the four scales between those students who "dropped out" during their first year (a total of 43) and those that continued into the second year (a total of 99) where their questionnaire data was available, which was actually n=20, and n=82 respectively. There were no significant differences found between these two groups for the four scales MM1, MR1, CMC1, FMC1.

However, as already noted in Chapter 2, the reason why students dropped out during their first year were many and varied (from illness, to disliking London) so this criterion would not necessarily be an indicator in terms of approaches to studying or conceptions of mathematics.

Tests were therefore also done to compare those students who failed the first year exams with those that passed (i.e. ignoring those students who dropped out of the

first year for other reasons) and also those that failed the mid-sessional test with those that passed, noting that 40% was considered to be the pass mark in both of the mid-sessional tests and the end of year exams. For both of these comparisons no significant differences were found between the four scales, although for the mid-sessional tests those that failed did have a tendency to have more fragmented conceptions of mathematics (significance level 0.061), but this result is not that surprising given the correlation already discovered between these two factors.

The significance of the students' performance in the mid-sessional tests but not in any other assessments is still difficult to explain. It might be something to do with the nature of these tests, in that they do not count toward the students' final degree results, and so the motivation to do well in them is different. Or it could be the timing of the tests, in that they are half way through the first year, straight after the Christmas vacation and therefore not only have students had relatively little time to adjust to the ways of working at university, but also have not necessarily done much revision while at home with their families for the first period of time of any length. However, although statistically significant, the correlation coefficient is very low so could also just be a spurious result.

v. How did contextual factors impact on these students' approaches to studying mathematics and conceptions of mathematics?

To help explain more fully the apparent lack of change in approaches and conceptions of mathematics over the three years, as well as why no clear relationship was found between each of them and examination results, I turn now to the individual students interviewed. The eight main participants in this study all ended up getting good first or upper second class honours degrees and yet scored very differently in their approaches to studying and conceptions of maths (see Tables 4.11 and 4.12). Please note these tables show the students' mean score for each of the four scales, as opposed to the total scores used in Table 4.1 when discussing the ranges for the cohort. The ranges, means and standard deviations for the averages of the four scales are therefore also given in Table 4.11 to enable a direct comparison.

	Range of average scores possible	**Range of average scores**	**Mean of average scores**	**Standard Dev of average**

		observed		scores
MM1	1 - 5	2.23 – 4.85	3.35	0.49
MM2	1 – 5	1.85 – 4.30	3.35	0.58
MR1	1 – 5	1.92 – 4.62	3.37	0.78
MR2	1 – 5	1.46 – 4.77	3.33	0.76
CMC1	1 – 5	1.78 – 5.00	3.72	1.53
CMC2	1 – 5	1.44 – 4.89	3.60	1.54
FMC1	1 – 5	1.00 – 4.60	2.92	1.67
FMC2	1 – 5	1.40 – 4.00	2.62	1.22

Table 4.11: Descriptive statistics for the four scales

Because of the apparent homogeneity of the eight main participants in terms of their success in examinations, in year three of the study I also interviewed two students (Adam and Charlotte) who had not been doing so well in terms of attainment, admittedly for different reasons, but again had very differing questionnaire results. Tables 4.11 and 4.12 show the average scores of these ten students for the four scales (meaning, reproducing, cohesive and fragmented) both times the questionnaires were administered. Where there are blanks in Table 4.12 this indicates that the student did not submit a completed version of Questionnaire D.

	MM1	MR1	CMC1	FMC1
James	2.7	2.2	4.0	3.1
Lyn	3.8	3.6	4.4	3.0
Hakim	3.8	2.1	2.6	1.8
Rafik	3.3	3.9	4.2	3.8
Sarah	3.2	3.4	2.9	3.2
Yen	3.9	3.5	4.2	3.2
Steve	2.6	3.5	4.2	3.1
Jane	3.2	3.0	3.0	2.2
Adam	3.8	2.7	4.2	2.8
Charlotte	2.8	3.7	3.1	3.5

Table 4.12: Students' average scores for Approaches to Studying Mathematics and Conceptions of Mathematics Questionnaires in term two of year one

	MM2	MR2	CMC2	FMC2
James	-	-	-	-

Lyn	4.1	4.2	4.9	3.2
Hakim	3.3	1.5	2.6	1.4
Rafik	3.8	4.2	4.1	3.3
Sarah	2.7	3.8	3.0	3.2
Yen	-	-	-	-
Steve	3.5	4.3	3.9	2.8
Jane	2.9	3.6	2.6	2.2
Adam	3.9	2.8	4.2	2.2
Charlotte	1.8	3.7	2.7	3.4

Table 4.13: Students' average scores for Approaches to Studying Mathematics and Conceptions of Mathematics Questionnaires in term two of year three

I will focus next on just four of these students, two who did well overall in their exams (Sarah and Hakim) and the two who did not do so well (Adam and Charlotte). Figures 4.1 through to 4.8 show the average scores for these four scales for each of these students. For each student I have shown their meaning and reproducing approaches to learning scores for both times they completed the questionnaires in one figure, and their cohesive and fragmented conceptions of mathematics on another. This is to enable a more direct comparison of the results from Questionnaire A and D.

Hakim

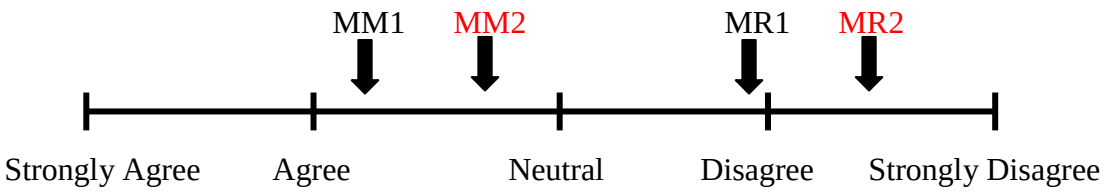


Figure 4.3: Hakim's results from the approaches to studying mathematics questionnaire, both times it was administered

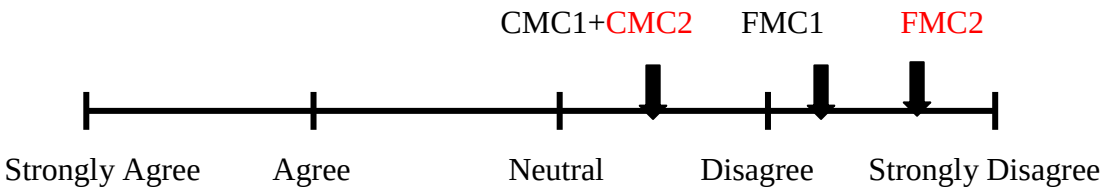


Figure 4.4: Hakim's results from the conceptions of mathematics questionnaire, both times it was administered.

Sarah

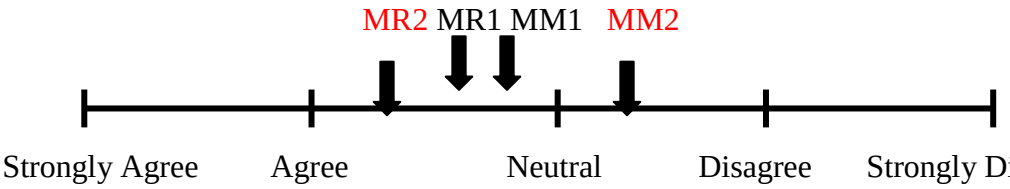


Figure 4.5: Sarah's results from the approaches to studying mathematics questionnaire, both times it was administered.

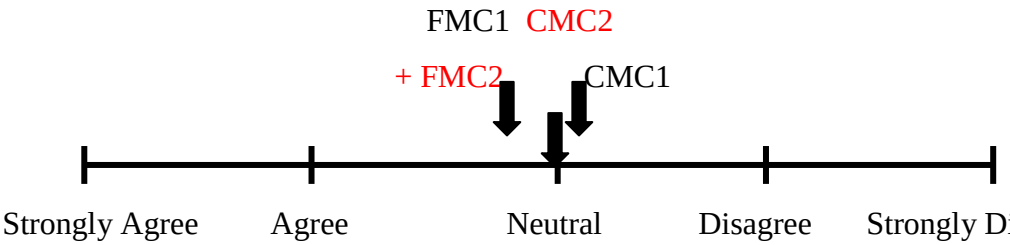


Figure 4.6: Sarah's results from the conceptions of mathematics questionnaire, both times it was administered.

Adam

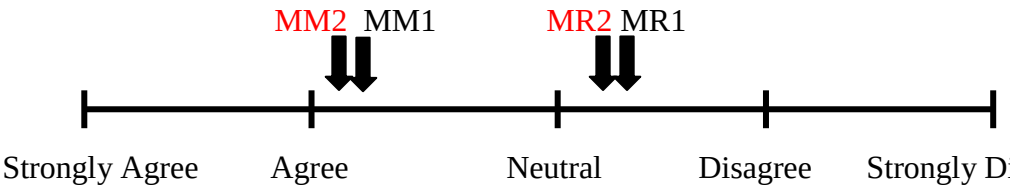


Figure 4.7: Adam's results from the approaches to studying mathematics questionnaire, both times it was administered.

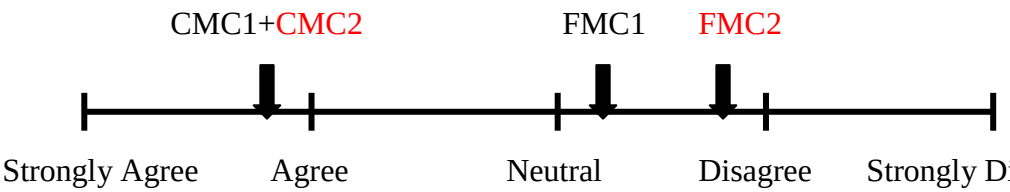


Figure 4.8: Adam's results from the conceptions of mathematics questionnaire, both times it was administered.

Charlotte

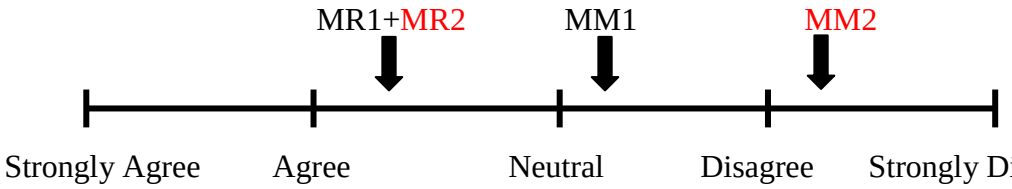


Figure 4.9: Charlotte's results from the approaches to studying mathematics questionnaire, both times it was administered.

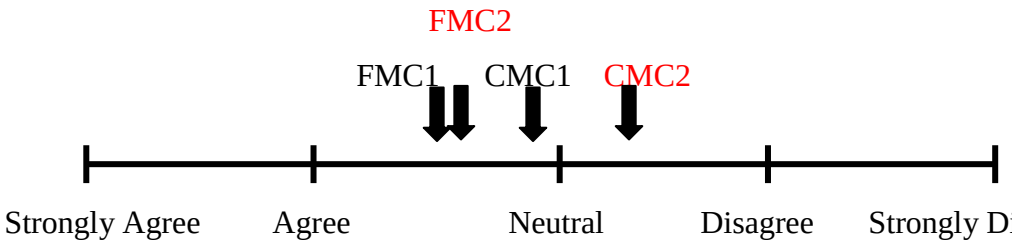


Figure 4.10: Charlotte's results from the conceptions of mathematics questionnaire, both times it was administered.

Comparing these four students we can see clearly that Hakim and Adam both have higher scores for MM1 and MM2, than MR1 and MR2, and CMC1 and CMC2 than FMC1 and FMC2, i.e. they show a more meaning orientation to their studies, and a more cohesive conception of maths. Sarah and Charlotte however show the opposite tendencies i.e. a more reproducing orientation and a more fragmented conception of maths. This is true both at the beginning and end of their degree.

I chose to concentrate on these four students as examples as they highlight these differences, but also they follow the trend of the results from the cohort, in that their results at the beginning and end of their degree do not change significantly. While Hakim and Adam have similar results for the four scales, as do Sarah and Charlotte, when looking at their examination results it is Hakim and Sarah who both did well, and Adam and Charlotte who struggled. In terms of their approaches to studying mathematics, their orientations come through clearly in their interview data, and there are also indications as to their conceptions of mathematics.

Case study one: Hakim was confident and chatty even when I first interviewed him. The eldest of three brothers, he grew up in Belgium and studied the International Baccalaureate at the European School in Brussels. His mother is a secretary and his father owns and rents out properties. Throughout most of his secondary education Hakim felt he wanted to study computer science at degree level but became increasingly interested in mathematics during his last two years of schooling.

> Well, Computer Science, I liked computers, computer programming. I suppose, it's one of things with Maths, it was purely out of interest, I liked it so much that I decided to do it, and so applied for Maths and Computer Science, I suppose, I might not be that good at Maths, if it doesn't work out, then I'll just do Computer Science. [Hakim]

In actual fact he subsequently dropped the computing modules of his joint honours degree to study single honours mathematics instead.

I asked Hakim in his first interview what he liked about maths. From his reply he appeared to be enthusiastic about it and have quite a "cohesive" conception of mathematics as a subject.

> I've asked myself this question a few times. It's a difficult question to answer, isn't it? Obviously, one of the reasons was that I'm pretty good at it. But I was quite bad at it, actually, before I got interested in it. Once you're interested in something, I suppose you become better at it. With Maths, I don't really see it in terms of symbols and, and calculations and numbers, I see it in terms of ideas. And I think it's kind of the purer subjects, in my opinion, . . . ideas. And although there's a proof – it's not about the little tricks and everything, with the algebra and everything, it's about the idea, where did it come from. You know, it's just always that sort of flash of inspiration, that's the aspect that I've always liked. And you really prove something, if you like, you're completing a jigsaw puzzle or games or whatever, it's just like that. It's so vast, there's so many different things, so much. You'll never know all of it. Also, I suppose, one of the aspects is that, most people don't really understand Maths, don't really like that, and when you do understand it, you kind of feel kind of special in a way, you understand it, . . . Probably one of the reasons. [Hakim]

Later in the same interview he reiterates that he likes the fact that many people think of maths as a difficult subject, and that because he can do it he is somehow special.

> I think, as I said earlier, it's one of the reasons that I like it, it's kind of so distant from everything else, it's so far apart from the real world. You're kind of part of an elite, in some ways. [Hakim]

His enthusiasm for maths is also shown by his interest in reading around his subject, some of the history of mathematics and learning how the subject fits together. He

obviously has an intrinsic motivation for studying mathematics but he has also thought as far as having an academic career.

> Hopefully, I'd like to become a Mathematician, that would be an ideal situation. It's not guaranteed, I might not be that good at Maths, or not good enough. I've already decided that if it doesn't look like I'll be good at it, I'm not just going to spend my time struggling to get to be, you know, a very average Mathematician, that doesn't interest me. So, if I'm not going to be good, good enough or whatever. If I'm not going to make any contribution, there's no point. [Hakim]

In his third year Hakim also spoke about how he had been doing a "reading course" with one of the lecturers outside the main curriculum of the compulsory and optional modules. It was purely in terms of his own interest in a particular area of mathematics and again showed his intrinsic motivation.

In terms of his expectations of his fellow students he seemed to be quite disappointed. He was expecting to be one of the worst in the class because he'd had to study more subjects doing the Baccalaureate than his colleagues who had taken A levels. He also expected the other students to be much more interested in maths than they appeared to be.

> Yeah, a bit more enthusiastic. Also, not like at school, where if you're good at something, people almost look down a bit, you know, . . ., it seems to be the same attitude, basically. Some people, it annoys them when you answer their questions right, and it annoys them if you know something that they don't. And I really don't expect that kind of attitude from people who were supposed to be good at learning. I expected a more academic type of attitude. I don't really see the difference between school and here. [Hakim]

I also asked Hakim during his first term how he felt he was doing so far. He seems to judge his performance in terms of how much he feels he understands a subject. He is not particularly interested in coursework grades of even the then up-coming mid-sessional tests, although he did compare his results in these tests to those a friend achieved

> It's difficult to say. I normally don't judge my progress so much on what my marks are, because they're not really a good indication of how good you are, and you know that as the course goes on the harder it gets. You know, if you work a little bit and then you get a six, you work really hard, you get ten, but it doesn't change who you are, it doesn't change how good you are, it just means you worked hard. So that's not what I'm interested in. What it means is to be able to understand what we're doing. And so far in Analysis I feel like I understand things. [Hakim]

Case study two: In stark contrast to Hakim, **Sarah** came across as particularly quiet, shy and quite serious. Two of the interviews were conducted as a focus group with other students on the same joint honours course, and she only really spoke if asked a direct question. Even in our one to one interviews she did not open up and talk very much. She would give one word answers where possible and only elaborated if really pushed. Her mother is a housewife, her father is a shop worker, and she has one older sister. She went to an all girls grammar secondary school in Kent where she stayed on to take her A levels. She chose her degree in maths and physics because,

> I did A levels in maths and physics, and chemistry, and I didn't like the chemistry so decided to just drop that. [Sarah]

A few weeks into her first term Sarah felt that her expectations of the course had been proved right

> I knew it was going to be hard, it has been pretty much what I expected. I didn't do further maths. I thought it would be so much harder if you didn't do further maths, but those who did do further maths still find it hard. [Sarah]

After the mid-session tests in the first year, Sarah felt that they had gone quite well. In actual fact she averaged a high first! She felt this was because she had "revised it well" and knew what to expect having looked at past papers. There were also the first signs of her using memorisation as a way to get through her assessments.

> Well, I kind of knew what to expect from the papers, like Analysis, you've just got to learn the proofs . . ., it's just going to do the proofs on there, so that one was OK. [Sarah]

By the end of year two Sarah was still doing well in her exams but by now was much more vocal in her views on her approach to studying mathematics.

> I think it's all about memory. I think exams, . . ., like, analysis, the whole thing is just memory, you could not – I don't understand it, but if I've done well in it, it's just memorising it. . . . some of the other ones, I think that's the one that's mostly memory, but the other ones, you have to understand. [Sarah]

She was also asked how much she enjoyed mathematics now she had been studying it for two years.

> I just do it, I just don't enjoy it, I just do it. I wouldn't say I go into a lecture and I really find it interesting. I just can do it. [Sarah]

> I don't think I ever got enthusiastic, even at school, I think I just did it because I could do it. And some physics I did find quite interesting, but it's like when you have to keep memorising all these things, it just takes the enjoyment out of it. [Sarah]

When she was interviewed in her third year the subject of understanding came up again when Sarah was asked if she felt that mathematics came naturally to her in general, or whether she had to work particularly hard at certain modules.

> But, like, now I know that you don't always have to understand everything to do well in the exams. Like, maybe the first year I didn't know, but, now, I think, now, like, I'm more relaxed, like if I don't understand something I'm not really panicking and trying to understand it. I know – you can just use your memory to memorise it, you don't really have to understand it, but that's just in some subjects. [Sarah]

Case study 3: Adam was only interviewed once, in his third year, at which point he was studying part time. He was a mature student who had started a degree course in pharmacology several years previously that he had not completed. He had been doing some painting and decorating in the intervening years and continued to do this part-time alongside his studies. He had failed three half modules the year before, which he intended retaking, and was also attending the lectures for four out of eight of the third year half modules.

He explained his strategy in terms of the three half modules he was going to retake.

> The reason I decided not to try and learn those – because I thought I might be able to pass them but I'd just only scrape a pass…because if you turn up, the maximum you can score is thirty-five, at least if you turn up and put something down, with the re-sit, you know, you can do yourself some justice. And I had no time to actually revise these. So, I thought, yeah, just do that. So, I've got the three re-sits to do, plus the four this year. [Adam]

Adam was quite clearly intrinsically motivated, and was studying again because of his interest in the subject.

> I'm here because I enjoy mathematics and I want to understand it, not because I want to pass an examination and so, for me, it's more about that I get to grips with it. OK, this examination is a benchmark, have you had time enough to assimilate this information? Can you put it down within two hours? Well, to be honest, I'm not really interested in that, for me, it's more looking at it and getting to grips with it. [Adam]

However he acknowledged that rote learning was a way of getting through exams for some people.

> I achieved my highest mark in the first year, only because it was just state and prove. I said to my girlfriend, "I bet you could actually pass analysis without knowing what the hell was going on." If you've got a pretty good memory, then you write the proofs out over and over again, then you can do it. And I think that's a real shame because it's such a really nice subject, not that I'd want to

> study it much further than this, but it is great that everything is really proved and set down in stone. [Adam]

Case study 4: Charlotte was also interviewed just once in her third year. She has a younger brother who had just started at university, and swapped courses within a week of being there. Her mother lives a couple of hours away but for her second and third year she was living with her father in a flat, as he works in a hospital near to the university she is studying at. In her first year she was living in a hall of residence.

She had a long-term boyfriend whom she had met at school and who was studying at another university. They spent every weekend together, with either her travelling to stay with him, vice-versa or them both meeting in their hometown. Needless to say this was expensive and she was struggling with her finances.

At the start of the interview Charlotte said she had taken five A levels; Maths, Further Maths, History, IT, and General Studies. She was then asked why she had decided to study mathematics at university.

> Because I loved it at A level. Yeah, it was really good. I mean, A level, they said that they really preparing us to come to uni but then, when I got here, it was just so … nothing like what I expected. You can only do it, with your brain, like, in a certain way. I don't think mine does. [Charlotte]

Later in the interview I referred back to this statement and asked if she still enjoyed mathematics.

> Yeah, at A Level I really loved it but since I've been here, it's like they've taken something I love and crushed it and now I hate it and I never want to use it again. [Charlotte]

When asked to elaborate why she felt this she said,

> I don't know. I think one of the things that I don't like is the fact that they have to prove absolutely everything, then you're expected to be able to do it again and again, and I can't see the point of it. . . . (inaudible) … know how it works, why should you then need to be able reproduce it? I can't see the point of that, which is probably why I wasn't any good at analysis. So, that's one of the things that's caused me to not like it as much. [Charlotte]

Interestingly, although her questionnaire results show Charlotte adopts a reproducing approach to her studies she obviously found this an unsatisfying way to work.

> To me, maths is more about being able to do things, not being able to memorise it, I mean, that's what history is. And it wasn't like that at A Level, because I loved it then, the maths, I don't want to use it again. [Charlotte]

Discussion of interview data

First it must be noted that the interview data does support the validity of the questionnaire results in general, by reaffirming not only the particular approaches these four students adopt, but to some extent their conceptions of mathematics as a subject too. Quotes from all four students tallied with the results from their questionnaires, with Hakim and Adam having broadly more cohesive conceptions of mathematics than fragmented, and more meaning orientation to learning mathematics than reproducing. Sarah and Charlotte were the opposite, having more fragmented conceptions of mathematics, and a more reproducing approach to learning mathematics. In Charlotte's case things are somewhat more complex though, as she voices some reluctance to the reproducing approach that she clearly adopts.

The fact that these students spoke about memorisation as a key feature in their approach to their learning, particularly in terms of Analysis as a subject area, says something about the context of this study. The teaching and assessment methods in this mathematics department had an effect on the way even the most enthusiastic of students felt that they could achieve good results by rote learning. Although much emphasis is put on memorising being a "bad" thing for students to do, some is of course inevitable in any subject. What has to be considered is the nature of this memorising. Does it progress to a more meaningful understanding, by relating new information to relevant existing concepts, or merely a short-term retention, and subsequent regurgitation, of facts, as seems to be the case here in terms of rote learning of theorems for examinations.

Typically a student who admits to rote learning, or scores highly for a reproducing approach to studying, is often portrayed as failing in some way, although not necessarily in terms of exam results. Some of the students in this study show

maturity in their thinking beyond this stereotype. For example, Adam's comment to his girlfriend,

> I bet you could actually pass Analysis without knowing what the hell was going on. [Adam]

is particularly salient as he follows on to say that he finds it a shame that you could do this.

In their own way these students are acknowledging their perceptions of the "rules" of the assessment methods of the department in which they are studying. If they feel that some of the examinations test primarily for work that can be merely memorised without much fundamental understanding being required then even the most enthusiastic of students will resort to this way of working. Even if their predisposition is to take an overall meaning approach to their studies they soon realise that their Analysis exams, at least, do not require them to so.

One of the other students, James, who was highly articulate and considered any mark in an exam of less than about 90% a failure on his part, clearly understood this very early on in his course, in fact as soon as a formal assessment had taken place. In his interview soon after the first year mid-session tests he said,

> I didn't do enough work, especially in Analysis, because Analysis, the actual exam is rote learning. It's very odd because the whole course is one of the most… it challenges you more than the other courses, the first term, it makes you think more and, yet, when it comes round to the exam, they've just got prove - . . ., prove this and this and this, rather than – I mean, it makes one wonder why they have, on the homework sheets, all these things that you spend ages banging your head against tables for, to come up with solutions to these questions when, at the end of the day, it doesn't help you through the test, but it's fun to do, I suppose. [James]

Obviously the lecturers are trying to stretch their students' thinking, and encourage an understanding of the subject area, with the questions they set for coursework. A student like James enjoys the challenge that these present him, but then is disappointed with the examination questions.

Discussion and conclusions

Returning to my five subsidiary research aims for this chapter, I found that several of my findings were in keeping with results from previous research. Firstly, there was a positive correlation between meaning orientation of studying mathematics and cohesive conceptions of mathematics, and a positive correlation between reproducing orientation to studying mathematics and fragmented conception of mathematics for this cohort. In other words those students who take a meaning approach to their studying tend to also have cohesive conceptions of mathematics, and those who take a reproducing approach tend to have fragmented conceptions, which is in line with previous research e.g. Crawford et al (1998a).

Secondly, in terms of age being a factor affecting the scales under investigation, the first time the questionnaire was completed, the mature students were statistically more likely to have adopted a meaning approach to studying than their traditional counterparts. This is in agreement with previous research and, as outlined by Richardson (1994), there are underlying reasons for these results, the primary one being that mature students are more likely to have an intrinsic motivation towards their studying. This in particular should be taken into consideration in terms of widening participation and departmental policy on admissions. Only one mature student completed the questionnaire the second time it was administered so no comparison was possible.

Lastly, gender did not appear to be a factor that had a statistically significant effect either times that the questionnaire was administered. Again, this is also in agreement with previous research e.g. Richardson (1994, 1995) and Magee et al (1998).

However, there were findings from the statistical analysis of the questionnaire data that appeared to differ either from results prior research, or from what might have been expected. The first was that for the students' approaches to learning mathematics, and conceptions of mathematics, there was no evidence of any change over the period of the degree course. No statistically significant difference was found in all four scales i.e. meaning and reproducing approaches, and cohesive and fragmented conceptions, between both times that the questionnaire was administered.

This implies that this teaching and learning context had no effect on the approaches to learning, nor the conceptions of mathematics, of the 28 students' that completed the questionnaire both times it was administered.

The other result from my study that differed from previous research was that no correlation was found between academic success, in terms of examination attainment, and either the students' conceptions of mathematics, or their approaches to learning mathematics. Previous research by Crawford et al (1998a) with undergraduate mathematics students had suggested a significant positive relationship between meaning approaches to studying mathematics and higher attainment, and similarly work by Reid et al (2005) reported a consistency between students' intentions for learning mathematics and the outcomes of their studying.

These two results from my data are particularly interesting in combination, especially when the year on year correlation of examination results is also considered. What they tell us is that for the group of 28 students who completed the questionnaire both times, not only did their conceptions of, and approaches to, mathematics not change during their degree, their examination results did not correlate to either their conceptions or their approaches, but their examination results in different years did correlate. In other words, those students who did well in the first year continued to do so through to their final year exams, with no change in their conceptions of mathematics, or approach to learning mathematics, whatever they were to start with. And similarly for those who did not do well in their examinations. As was also seen there was no significant difference between those students who failed their first year examinations and those that did not, at least in terms of their approaches to, and conceptions of, mathematics as measured by the questionnaires.

In order to try to explain these results, I turned to my final subsidiary aim within my research question for this chapter and investigate whether any contextual factors in terms of this department could have had an effect. I did this by looking at four of the individual interviewees and exploring both their questionnaire and interview data to help explain possible reasons for these trends from the whole cohort. From their questionnaire results it could be seen how much these four students differed in their approaches and conceptions, but also how their scores on these scales contrasted

starkly between the two students who had achieved high results in their examinations, as well as for those two who had achieved much lower examination results. These comparisons again confirmed what had been seen for the cohort, that there was no apparent correlation between examination success and approaches to learning, or conceptions of mathematics.

However, the analysis of their interviews did highlight one of the contextual factors that had an effect on these students' conceptions and approaches to studying mathematics, that being nature of some of the assessments of this particular department. The students all mentioned that for some of the examinations the problems set relied heavily on them using rote memorisation. In terms of their approaches to learning mathematics they were therefore merely adapting to the context of the department and the assessment tasks in their examinations. This is not surprising given the situated nature of approaches to learning (Laurillard, 1979, Marton, 1993), and this department also does not appear to be an isolated case. As already mentioned a study by Mji (2003) also found no correlation between students' approaches to learning and their examination results, amongst a cohort of mathematics students at four universities and one Teacher College in South Africa, and concluded,

> "In assessing students' conceptions and orientations to learning mathematics, this study has shown that these depend on instructional methods, the environment in which students find themselves in as well as methods of assessment used by their lecturers." p. 696-697

However, despite these students acknowledging these "rules" of the assessment it had no effect on their approaches to learning mathematics during the period of their degree course. Those students who started the course with more meaning approaches, would adopt a reproducing approach if that is all they felt was required in an examination, but still did not change their underlying belief in a more meaning approach when it came to how they completed Questionnaire D. This was in keeping with previous research (Thomas and Bain, 1982, 1984). Those students who started the course with more reproducing approaches saw no real reason to adopt more meaning approaches to their learning, at least that is how they perceived some

courses, and yet some did still acknowledge that this was not how they wanted to be assessed.

What is probably more of a concern is that the students' conceptions of mathematics do not change during their degree. Had these 28 students all started their degree with broad conceptions of their subject this lack of change would not be a problem, however the questionnaire data shows this not to be the case, and again is backed up by the interviews. Professional mathematicians hold broader conceptions of mathematics than those categorised as *fragmented* by Crawford et al (1994) or as *number* or *component* by Reid et al (2005) and yet if the 28 students who completed both questionnaires are representative of the whole cohort, then there is no evidence that the students' conceptions changed over the period of their degree. This should be of particular concern in terms of those students who decide to pursue a career in teaching. If they leave university with a good degree grade and yet still hold a very narrow conception of mathematics, as was seen for two of the case study students, they will be passing this on to the next generation of school pupils.

Why these students' conceptions of mathematics did not change over the three years is concerning, and yet also difficult to fully explain. Previous research findings have indicated that students in later years of their degree are more likely to hold broader, or more cohesive, conceptions of mathematics (Petocz et al, 2007), and yet this does not seem to be the case with this group of students. Also, Perrenet and Taconis (2009) proposed that through encountering more open mathematics questions at university, compared to school, students develop problem solving beliefs and behaviour shift in students, towards those of their lecturers. As seen from the questionnaire data this cohort entered their department displaying the full range of possible conceptions of mathematics derived from their school experiences, but without a more detailed investigation of the teaching and assessment methods used within this department, it is difficult to do anything other than speculate on why their conceptions of mathematics did not appear to change during their course. This will be discussed further, and some suggestions made, in Chapter 8.

When analysing these four students' interviews I was struck by how much some of the social factors of their experiences had influenced them. This, along with a couple

of aborted attempts at analysing all the interview data (as described in Chapter 2), led me to rethink my approach and take my study in a new direction. The next chapter therefore introduces the literature that influenced me and provided the framework for data analysis of all the students interviewed that will be presented in Chapters 6 and 7.

Chapter 5: Literature Review – The Social and Academic Aspects of Student Experiences, Support, and Identity

Introduction

The four case studies from the previous chapter, and the resulting data analysis of these students' interviews led me to start to think about the students' experiences in a different way. However, as already discussed in Chapter 2 it took several attempts at analysing their interviews before two other themes of interest emerged. These were the support the students did, or did not, receive, from their peers, staff and, to a much lesser extent, family, and secondly the impact of the students' experiences, during their degree course, on their identities.

While developing my thoughts on these themes of support and identity, I investigated literature from another area of research in higher education, that of student retention and attrition. Its focus on both the social and academic aspects of students' experiences at university, and how they are both important in terms of a students persisting with their course, struck a chord with much of what the students I interviewed had spoken about, and influenced how I decided to structure my data analysis, to be presented in chapters 6 and 7.

This chapter therefore introduces this background literature to help explain my decision to look separately at the social and academic aspects of my interviewees' experiences, while acknowledging the overlap between the two, but also why, although helpful in part, I felt ultimately that the theories within this literature did not help me to explain my data fully.

Retention and Attrition research in Higher Education

As already noted, until relatively recently psychologists have traditionally dominated the field of educational research, at least in terms of the understanding of student

learning and development. However, much of the work on how universities as institutions, and their educational programmes, affect student outcomes during this period has been more sociological in nature. In particular, Spady and Tinto's theories on student retention and attrition borrow heavily from sociological concepts.

Spady's theory (1970, 1971) applied Durkheim's analysis of social factors involved in suicide (1951), to the problem of student attrition. Spady proposed that students' decisions to leave university are influenced by: family and individual educational background, academic potential, peer support, intellectual development, academic performance, social integration, satisfaction and institutional commitment. He argued that Durkheim's "shared group values" was analogous to academic integration and "friendship support" to social integration. Spady's main point was that it is students' past experiences and interaction with the institution that influences their decision to voluntarily drop out.

Tinto's (1975) model of student attrition, which he later refined (1988, 1993), was an extension and refinement of Spady's work. The central concept of Tinto's model was that student persistence is directly related to their integration into both the social and academic world of the university, and is therefore often referred to as the student integration model (SIM). He also introduced Van Gennep's (1960) three stages of movement of individuals between groups, i.e. separation, transition, and incorporation, and applied them to the transition from school to university.

As Mannan (2007) states,

> "Tinto's model posits that students enter into higher education institutions with a variety of attributes, family and community backgrounds, educational experiences and achievements, skills and value orientations. These background characteristics and individual attributes develop educational expectations and commitments, which the individual brings with him/her into the universities and colleges. As a member of the community, students interact with the academic and social systems of the college, which determines persistence or dropout. The higher the degree of integration of the individual into the college system, the greater will be the commitment to the specific institution and to the goal of college completion leading to persistence." p. 147-148

Particular aspects of Tinto's theory are discussed in greater detail by researchers, such as Terenzini and Wright (1987). They concluded that for students on four year degrees (common in the United States) the level of academic and social integration in the first year is expected to have a positive influence on the level of integration in the following years but that,

> "Perhaps the most significant finding of this study is that the relative importance of students' levels of academic and social integration appears to reverse over the four-year period. In the freshman and sophomore years, academic integration is clearly the most important influence on reported academic skill development during those years. By the junior year, however, the influence of academic integration appears to begin a decline, while social integration begins to grow in influence. By the senior year, however, the reversal is completed: students' level of social integration appears to be slightly more influential than academic integration in reported senior year academic growth." p. 176-177

concluding that,

> "The evidence clearly suggests that students may play a larger role in one another's education than we have previously thought." p. 177

As mentioned, another major aspect of Tinto's theory is that of the movement of individuals from membership of one group to another. Dutch anthropologist Van Gennep (1960) contended that this process was marked by three distinct stages, or "rites of passage": separation, transition and incorporation. Tinto extended these stages (1987, 1993) to the process of students establishing membership of communities within a university, positing that unsuccessful negotiation of all three stages for an individual results in them failing to become integrated in the intellectual and/or social fabric of the institution (Boyle, 1989) and therefore departing from the institution. This final result, Tinto argued, is in parallel to Durkheim's concept of egotistical suicide.

Research by Elkins et al (2000) looked specifically at the separation stage of Tinto's model and its influence on student persistence in the first semester of college.

> "Separation occurs prior to and at the outset of the institutional experiences in both the academic and social systems. As students enter college, they are required to disassociate to some extent from membership in communities of the past, such as families, friends, the local high school, and local areas of

> residence. This separation constitutes the first stage of passage into the college career and may require some personal transformation and possibly rejection of the norms of past communities." p. 252

One of their main conclusions was that successful passage through this separation stage,

> "is enhanced by students receiving support from members of their past communities." p. 265

Separation does not therefore mean just cutting themselves off from their past, it can mean different things for different students, depending on their background. Especially for those who are first generation university students the support of their previous communities (family, friends, school teachers etc) has a positive effect on their persistence during their first year at university. However, for those students whose previous communities have negative views pertaining to studying at university they face a more difficult task in that they need to be willing, if necessary, to reject the attitudes and values of members of their past communities.

Another recent article by Severiens & Schmidt (2009) makes the distinction between formal and informal integration, as sublevels of the concepts of social and academic integration, and argue that each are equally important. They describe these two sublevels thus:

> "While formal academic integration involves the contacts related to studying and the institute itself, informal academic integration involves contacts between teachers and students outside the direct context of the learning environment, i.e. whether students and teachers consider themselves to be at more or less the same level socially, and whether they discuss personal matters with each other. Similarly, at the level of social integration, formal integration mainly involves contacts between peers on matters of learning." p. 60

In other words academic integration is concerned with the students' interaction with staff, both formal (related to study) and informal (related to personal matters). While social integration is concerned with the students' interaction with their peers both formal (related to study) and informal (related to personal matters). For Severiens & Schmidt (2009) this distinction is particularly important within social integration as their study explored the effects of problem-based learning (PBL) on social and academic integration and study progress.

However, for the purposes of the next two chapters I have also adopted a slightly different distinction in the terminology I use than that used by Severiens and Schmidt. The first of my two research chapters focuses on social support, what they refer to as informal social integration. The second chapter then focuses on academic support by looking at, in their terminology, both formal social integration and formal academic integration. In other words I split my analysis between the social and academic aspects of the students support from others, be they peers or staff, and not as Severiens and Schmidt do by defining all interactions with their peers as social integration, and all interactions with staff as academic integration and then subdividing these into formal and informal. The students in my study spoke little, if at all, about informal academic integration i.e. interaction with staff socially, or on personal matters.

Although there are other models of students attrition and retention (e.g. Astin, 1984, and Bean's, 1980) Tinto's has proved to be the most widely referred to in subsequent research (e.g. Terenzini and Wright, 1987, Elkins et al, 2000, Mannan, 2007), as well as attempts to bring different models together, see Milem & Berger (1997). The majority of this research continues to support the importance of integration of students during their time at university, in terms of student persistence, but there is also recent research that claims these two forms of student integration positively influence study attainment (Eggens, 2007).

Tinto's model has however been questioned in terms of whether integration is a cause or effect of student experiences. There are also doubts as to whether it is relevant to non-traditional students. Brunsden et al, (2000) for example, do not support Tinto's model, and suggest that,

> "interactionist and ethnographic approaches may result in a more appropriate theoretical framework." p. 30

McQueen (2009) also examined the appropriateness of models of attrition and argued that,

> "a more contextualized, nuanced and psychosocial approach to understanding student participation and retention is needed to address difficulties and inequalities in the transition to higher education". p. 70

Social Support

Social support is a term used both in sociology and psychology research, especially in studies of its relationship to physical illness or psychological disorder. As Turner (1999) reports,

> "Social support refers to one's social bonds, social integration, and primary group relations – all concepts central to sociological theory and research. Social bonds and supportive relationships with others are essential to mental health; furthermore, social support can protect people from the effects of stressors….The major hypothesis in this research is that low levels of social support increase risk for depressive symptomatology." p. 198

Its use as a concept has been argued to be too broad (Barrera, 1986) but as Turner (1999) goes on to say, although social support has been addressed by many researchers under various different labels (e.g. "social bonds", "social networks", "meaningful social contact" as well as "social support") and although these concepts are not identical, they do share a focus on the relevance and significance of human relationships.

Social support has been theorised in different ways and a broad definition is sometimes used, encompassing social integration (Weiss, 1969, 1974). Weiss's early work conceptualised social support as comprising six functions of personal relationships - attachment, social integration, opportunity for nurturance, reassurance of worth, a sense of reliable alliance and the obtaining of guidance - each ordinarily associated with a particular type of relationship. However, House and Kahn (1985) usefully distinguish between social integration and social support, so that whereas social integration refers to the structural aspects of social relationships, social support refers to the functional content of relationships such as the perceived or actual support received. A number of different types of social support have been identified, including emotional, instrumental, informational and appraisive (House, 1981).

As my study does not have the relationship between life stress and illness (whether mental or physical) as a primary focus I will, for the purposes of this thesis, be using social support as a loose all encompassing term, that I will use more or less interchangeably with the other similar ones, e.g. social bonds, social networks etc as mentioned earlier in this section. That's not to say that its relationship to mental and

physical health during stressful periods of a person's life isn't relevant to my work. The stress of starting at university, coursework load during the academic year, and exams can all have an effect on student's health, and lack of social support at these times can aggravate this effect.

An article by Wilcox et al (2005) stresses the role of social support with first year undergraduates in terms of their decision whether or not to leave university, within the first year of their degree course. They did this by using the concept of social support to analyse interviews with 34 students, and investigate the processes of social integration (or lack of it), and found that emotional support to be the most prevalent of the types of social support provided by student friendships.

> "Our data support the claim that making compatible friends is essential to retention, and that students' living arrangements are central to this process. Such friends provide direct emotional support, equivalent to family relationships, as well as buffering support in stressful situations. Course friendships and relationships with personal tutors are important but less significant, providing primarily instrumental, informational and appraisive support." p. 707

My data analysis in Chapter 6 will be focusing on how one particular group of students went about finding the social support they required at different stages of their time at university, and how this support helped in terms of their social integration into university life.

Sense of Belonging

Hurtado and Carter (1997) argue strongly that Tinto's model of social integration is not applicable to minority groups of students, and in fact that the term "integration" itself is unclear. They put forward the term "sense of belonging" as more encompassing, it being one of the two dimensions of "perceived cohesion", the other being feelings of morale associated with group membership. Perceived cohesion captures the extent to which individuals feel part of particular social groups.

The origins of research into people's sense of belonging are also rooted in mental health, becoming prevalent in both education and nursing literature during the early 1990's. A sense of belonging is defined as the experience of personal involvement in

a system or environment so that persons feel themselves to be an integral part of it (Hagerty et al, 1992). Within a school setting a sense of belonging has been researched in terms of its importance to academic achievement and motivation (Goodenow, 1993, Goodenow & Grady, 1993, Willems, 2003) whereas in Higher Education the emphasis has mainly been on attrition (e.g. Yorke, 1999, Hoffman et al, 2002) and the experiences of student minority groups e.g. part-time students (Kember et al, 2001), ethnic/racial groups (Johnson et al, 2007).

A sense of belonging however is also not necessarily limited to the perceived cohesion, or feelings of morale associated with group membership. Solomon (2007) focused on a group of mathematics undergraduates and their feelings of 'not belonging' in terms of their experiences of studying mathematics and understanding of their subject. As she describes many students,

> "…are aligned with the mathematical procedures but do not contribute towards them." p. 79

In her account she compares the students' experiences in terms of Wenger's (1998) three modes of belonging: alignment, imagination and engagement, as well as combinations of the three, while acknowledging an individual's positioning identity within multiple communities of practice. Solomon concludes that,

> "…some potentially successful students develop negative relationships with mathematics which marginalise them and can turn them against further study. Within the undergraduate community of practice, the dominant discourse of performance within which mathematics identities are constructed dictates the apparent functionality of particular identities." p. 93

Much of the students' experiences, and feelings of marginalisation that Solomon discusses rings true with the students in my study too. However I did not find the same gender differences within the group of students I interviewed.

A recent study by Palmer et al (2009) focused on the first 6-8 weeks of student life at university and looked for "turning point" experiences in the first year transition. They refer to the importance of students 'not belonging' within the university environment as put forward by Solomon (2007), but extended her argument

> "…by assuming a more active role for 'liminality': derived from the Latin word limen, meaning threshold. In doing so, the study contends that students can be suspended between one place (home) and another (university), which can result in an 'in-between-ness' – a betwixt space – which, in turn, creates this lack of belonging or sense of placelessness (Van Gennep 1909/1960)." p. 38

This refers back to Van Gennep's rites of passage, as described earlier in this chapter, and looks specifically at the transition stage, which they refer to as 'a betwixt space'.

> "The idea of a turning point would, therefore, theoretically sit well within the betwixt space. For the purposes of this study, a turning point is defined as an event(s) or an experience(s) in the first six to eight weeks at university that stands out, and which triggers and results in the student developing (or not) a sense of belonging to university life. There can, therefore, be individual differences in the experience of the turning point, including the development before the transition, the timing of the transition for the individual, the individual's experience of navigating the transition, and the context in which the transition occurs (Rutter 1996)." p. 41

I would argue that in terms of developing (or not) a sense of belonging, this transition period or betwixt space, and the turning point experiences that occur within it, can take place over a longer period than the six to eight weeks that Palmer et al investigated. This will hopefully become apparent within my data analysis presented in Chapters 6 and 7. However, I do acknowledge that for many students these first few weeks of being at university are a crucial period in terms of their decision of whether or not to leave their course entirely.

Implications for my analysis

The research on students' approaches to learning and conceptions of mathematics shaped my data analysis in Chapter 3, but ultimately did not provide me with enough of an explanation of factors specific to the context of this study. Similarly, the literature on student retention and attrition helped provide me with a way of structuring my next two data analysis chapters, but again the theoretical models inherent in this literature ultimately did not help me answer my research questions.

My decision to organise the next two chapters in this way, started to form when it became apparent that the students I interviewed had spoken more about their

concerns with social issues such as “making friends”, than worries about their academic work, even though in one of my first attempts at analysing the data from the fifth round of interviews (as described in Chapter 2) it appeared that this emphasis was the opposite way round and more focused on academic matters. Although there is an obvious overlap between the social and academic sides of student interaction, the terms social and academic integration, and their formal and informal sub-divisions that emanate from the student retention literature, helped me to divide my analysis of the students interviews, while also providing me with evidence as to the importance of social support.

By choosing to focus on the social aspects of the students’ lives at university in the next chapter, I am in effect putting to one side the fact that these students all studied for joint or single honours mathematics degrees. This does not mean that I am ignoring the mathematics aspect of their identities, or that it does not feature, but although identity does not neatly fall into different categories in this way, for the purposes of this thesis I have taken the liberty of splitting my data analysis as such. Where there is overlap I will always attempt to acknowledge it, but in the final data analysis chapter, Chapter 7, my focus will be on the issues of academic support the students sought, and therefore this is where mathematics will come more to the forefront.

Chapter 6: Social Support and Sense of Belonging

Introduction

In this chapter I will be focussing primarily on what the interviewed students said about the social support they gained from their peers i.e. the interactions with their peers in terms of non-academic matters, akin to the informal social integration into university life defined by Severiens & Schmidt, 2009. This can be hugely stressful time for students in terms of uprooting themselves physically and emotionally from their family and friends, establishing themselves in new social and academic situations, and learning to become more independent. By exploring these issues I highlight the ways in which different students start to find their "place" in the institution, and a sense of belonging, the different things they are looking for in terms of social support at different times, and how they find them.

I will be looking at three main categories that emanate from the data in terms of locations where the students interacted with their peers, those being; the student's *accommodation*, the student's *department*, or departments in the case of those taking joint honours, and the *wider institution*, i.e. the rest of the university outside of the previous two categories. As there was so much to discuss under the category of accommodation, I subdivided this under the headings "living with other students" and "living at home". The three main categories also provide a longitudinal dimension to the data as the students spoke most extensively, although not exclusively, about accommodation in their first year, and their department and wider institution more in their second and third years of their degree. This is in line with Wilcox et al's (2005) study of first year undergraduates where students' living arrangements were central to the process of making compatible friends, which in turn was found to be essential for student retention.

However, before I turn to my data I look at some of the theoretical perspectives that have influenced my analysis. Maslow's hierarchy of needs came to the foreground while investigating the literature on human needs and motivation. While this, and other literature in this field, did provide me with more evidence of social support being vital to human well being, it then came to nothing much more than this, as it

lacked both empirical evidence in terms of its hierarchy, and any sustained agreement amongst developmental psychologists as to the actual identification of human needs.

The theoretical perspectives so far investigated had helped me both to start to understand why students had particular concerns at particular times during their degree, and to structure my analysis in terms of the focus of this chapter, and the next, but still I did not feel they had helped explain the students' trajectories in the depth I was aiming for. I therefore turned my attention toward the theoretical background of identity work in terms of both the social and individual aspects.

The chapter therefore starts with a section primarily focused on theory, both in terms of needs and motivation, and identity, with some explanation as to why I feel it relates to my data. This is followed by my data section with references back to the theory, and finishes with my discussion where I will attempt to firmly link together both theory and data, as well as drawing conclusions.

Theoretical background

Motivational Needs

I turn my attention therefore firstly to basic human needs, and specifically Maslow's theoretical hierarchy of human needs. In 1943 Maslow first hypothesized that all of us are motivated by inborn needs. At this time he proposed four deficiency needs and one growth need. Within the deficiency needs, he proposed that each lower need must be met before moving to the next higher level. He defined these deficiency needs as:

1) Physiological: air, food, drink, shelter, sleep, etc.

2) Safety/security: out of danger, protection from elements, law, order, limits, stability etc.

3) Belongingness and Love: affiliate with others, be accepted, affection, relationships, etc.

4) Esteem: to achieve, be competent, gain approval and recognition, independence, prestige, etc.

The fifth, growth need he defined at the time as self-actualisation. Self-actualised people are characterised by: being problem-focused; incorporating an ongoing freshness of appreciation of life; a concern about personal growth; and the ability to have peak experiences. Maslow proposed that an individual is ready to act upon the growth need if, and only if, the deficiency needs are met.

However, Maslow later added three other growth needs, defining a level beyond self-actualization (Maslow, 1971) and subsequently two lower-level growth needs (Maslow & Lowery, 1998). The four growth levels he eventually proposed were therefore:

5) Cognitive: to know, to understand, and explore;
6) Aesthetic: symmetry, order, and beauty;
7) Self-actualization: to find self-fulfillment and realize one's potential; and
8) Self-transcendence: to connect to something beyond the ego or to help others find self-fulfillment and realize their potential.

His theory states that individuals must satisfy each need in turn, starting with the first, which deals with the most obvious needs for survival itself. Only when the lower order needs of physical and emotional well-being are satisfied would someone be concerned with the higher order needs of influence and personal development.

In spite of a lack of empirical evidence to support his hierarchy (Wahba & Bridgewell, 1976; Soper, Milford & Rosenthal, 1995) Maslow's theory of human motivation has become one of the most popular and often cited. In more recent years however, there has been little agreement amongst researchers in developmental psychology, both on the identification of basic human needs and how, or indeed if, they are ordered. However, one common component from recent theories (e.g. Ryan & Deci, 2000, Thompson et al, 2001, and Nohria et al, 2001) is that humans do exhibit a need to bond with, and relate to, others.

In 1969 Alderfer developed Maslow's hierarchy of needs, into his ERG theory (Existence, Relatedness and Growth). He categorized the lower order physiological and safety needs as "Existence", the interpersonal needs of love and esteem into

"Relatedness", leaving the "Growth" needs as Maslow had proposed. He did not assume, as Maslow did, that lower-level satisfaction was a prerequisite for the emergence of higher-order needs, but did propose that the impact of higher-order frustrations related to the strength of lower-order needs. Alderfer therefore proposed a regression theory to go along with his ERG theory. He said that when needs in a higher category are not met then individuals redouble the efforts invested in a lower category need. For example if self actualization or self esteem is not met then individuals will invest more effort in the relatedness category in the hopes of achieving the higher need.

Although this does not appear to be a huge development of the original theory, I find that Alderfer's three tier hierarchy less restrictive than Maslow's. In terms of the data I will present in this chapter, I found that "relatedness" (which covers Maslow's third and fourth "deficiency" needs) encompassed the issues that the students raised. I have not concerned myself here with the students' "existence" needs.

I hope to show that the evidence from my data is that "relatedness" is vitally important, and although I don't believe that the hierarchy is as clear cut as Maslow and Alderfer argued, there is a definite emphasis on "relatedness" as a deficiency need that the students are concerned with more than their cognitive "growth" needs, at the start of their degree. Alderfer's proposed regression theory is therefore something that I will need to return to in Chapter 7, when I turn my attentions more to the students' interactions with the academic side of their time at university.

I must also acknowledge here more recent research on "mattering", which has its origins in mental health (Rosenberg and McCullough, 1981, Taylor and Turner, 2001), and its use in American literature on Higher Education has been focussed primarily on student services and counselling. Mattering is defined as "the feeling that others depend on us, are interested in us, [and] are concerned with our fate" (Rosenberg and McCullough, 1981) and is related to the need for a sense of belonging and esteem proposed by Maslow (1943). Schlossberg (1984) identified the construct of marginality as the polar opposite of mattering, and in 1989 Schlossberg, Lynch, and Chickering applied these concepts to higher education by developing a mattering scale for use in determining whether policies, practices, and classroom

activities are geared toward making adult students feel that they matter. More recent research has looked at mattering in terms of academic stress and retention (Rayle and Chung, 2007, Madgett and Belanger, 2008).

However, although this terminology is more current in the literature, I find Alderfer's broader defined term of "relatedness" more relevant to my data, and have therefore decided to use it through this chapter. Having established these students' concerns and anxieties with making friends and establishing relationships as something that can affect their motivation and progression, I widened my literature search and turned my attention towards human interaction, rather than just individuals' needs.

Identity – Relational and Individual

Finally, I turn my attention to identity theories, to also help me to investigate the students' trajectories through their degree. The use of "identity" in social sciences has become more and more prevalent in the last thirty years, and yet its usage still varies both in terms of meaning and theoretical role. A comparison by Stryker & Burke (2000) between three relatively distinct usages, was reported by them as follows:

> "Some use identity to refer essentially to the culture of a people; indeed they draw no distinction between identity and, for example, ethnicity (see collected papers in Calhoun 1994). Thus they obscure the theoretical purpose of its introduction. Others use identity to refer to common identification with a collectivity or social category, as in social identity theory (Tajfel, 1982) or in contemporary work on social movements, thus creating a common culture among participants (Snow and Oliver, 1995). Finally, some use the term, as we do in the work underlying this paper, with reference to parts of a self, composed of the meaning that persons attach to the multiple roles they typically play in highly differentiated contemporary societies." p. 284

I discount here the former of these three distinctions and focus on the latter two.

Social identity theory (SIT) was first developed by Tajfel and Turner in the late 1970s. They proposed that a person has not one, "personal self", but rather several selves that correspond to widening circles of group membership, and that social contexts trigger an individual to think, feel and act on the basis of these different "levels of self". Social identity was defined by Tajfel (1981) as,

> "that part of an individual's self-concept which derives from his knowledge of his membership of a social group (or groups) together with the value and emotional significance attached to that membership." p. 251

Individuals therefore have multiple "social identities", which are the individual's self-concepts derived from perceived membership of different social groups (Hogg & Vaughan, 2002). In other words, it is an individual-based perception of what defines the "us" associated with any internalised group membership.

SIT also asserts that group membership creates self-categorisation and enhancement in ways that favor some groups at the expense of others. Tajfel and Turner's proposal was that there are three mental processes involved when making judgments on people we encounter: categorisation, social identification and social comparison.

Firstly, we categorise people (including ourselves) in order to understand our social environment. Similarly, we find out things about ourselves by knowing what categories we belong to. We define appropriate behaviour by reference to the norms of groups we belong to, but you can only do this if you can tell who belongs to your group, and an individual can belong to many different groups. "Ingroups" are then those a person identifies with, and "outgroups" are ones that they don't identify with, and may discriminate against.

Secondly we adopt the identity of the group we have categorised ourselves as belonging to, in a process of social identification. If for example you have categorised yourself as a student, the chances are you will adopt the identity of a student and begin to act in the ways you believe students act (and conform to the norms of the group). There will be an emotional significance to your identification with a group, and your self-esteem will become bound up with group membership.

Finally, once we have categorised ourselves as part of a group and have identified with that group we then tend to compare that group with other groups, this they designated as social comparison. If our self-esteem is to be maintained our group needs to compare favourably with other groups. This is critical to understanding prejudice, because once two groups identify themselves as rivals they are forced to compete in order for the members to maintain their self-esteem. Competition and

hostility between groups is thus not only a matter of competing for resources but also the result of competing identities. This theory presumes that group membership is not something foreign or artificial attached onto a person, it is a real, true and vital part of that person.

SIT therefore starts from the assumption that social identity is derived primarily from group memberships, and further proposes that people strive to achieve or maintain a positive social identity, thus boosting their self esteem, and that this positive identity derives largely from favourable comparisons that can be made between the ingroup and relevant outgroups. In the event of any dissatisfaction with the group identity people may seek to leave their group, or find ways of achieving more positive distinctiveness for it.

Identity work has also become more prevalent in the last two decades in educational research. Examples of theories that have been adopted and adapted within education include Lave and Wenger's work on situated learning (1991). Wenger's take on this initially looked at how newcomers join an established group or "community of practice" through a process of legitimate peripheral participation. Gradually, as newcomers become old timers, their participation takes forms that are more and more central to the functioning of the community.

Wenger has since moved away from the idea of legitimate peripheral participation and towards the individual as an active participant in the practices of social communities, and in the construction of their identity through these communities (Wenger et al, 2002), with his primary focus thus being one of learning as social participation. Wenger (1998) also argues that identity is the pivot between the individual and the collective. In this context, a community of practice is a group of individuals participating in communal activity, and continuously creating their shared identity through engaging in and contributing to the practices of their communities.

As Murphy & Hall (2008) describe in the introduction to their book,

> "…'becoming' and 'belonging' encapsulates the key perspectives with a sociocultural account of learning as a movement deeper into practice, and as a transformation of identity, where identity is understood as evolving forms of competence." p. ix

Holland et al. (1998) also refer to the idea of identity being people's self-understandings formed through experiences in particular cultural worlds and their social activity within those worlds. They also note that identity formation is an ongoing, ever-evolving process, and have suggested that not all people develop "much of 'an' identity" (p. 190) in particular cultural worlds as they may not ever be "sufficiently engaged" by that world.

Another approach to identity, which is also encompassed by the third of Stryker & Burke's categories, is the narratives that people tell about themselves. Research in this field focuses on questions of how individuals seek to make meaning of their lives, both how they understand themselves as unique individuals and as social beings who are multiply defined by life stage, gender, ethnicity, class, and culture. Sfard & Prusak (2005) for example put forward that,

> "The reifying, significant narratives about a person can be split into two subsets: actual identity, consisting of stories about the actual state of affairs, and designated identity, consisting of narratives presenting a state of affairs which, for one reason or another, is expected to be the case, if not now then in the future. Actual identities usually are told in present tense and formulated as factual assertions." p. 45

A major criticism of this type of research is that narrative researchers run the risk of providing descriptive rather than explanatory accounts of identity and personality, and that they may come across as too focused on the cognitive and conscious aspects of personality at the expense of the irrational, affective, and unconscious factors that shape individuals and their behaviour.

However, an emphasis on individuals' search to find a balance between autonomy (agency) and relationship (communion) while not trying to explain it in either evolutionary or biologic terms e.g. McAdams's (1990), I found to be more useful in terms of looking at what the interviewees in my study had to say about their time at university. Each individual student identified with different groups at different times

during their degree, as well as having very different experiences in terms of their developing independence.

My theoretical approach to the analysis of my data has become necessarily eclectic, in that I have not chosen one overarching theoretical framework to work within. Each of the theories outlined above have had complementary parts to play in the analysis of my data. The overall structure and framing of this chapter, and the next, have come from theories on motivational needs, and student retention and attrition. They have also helped me to explain these particular students' experiences of studying at university and their anxieties in terms of "relatedness" (Alderfer, 1972), "separation" (Elkins, 2000) and "informal social integration" (Severiens & Schmidt, 2009). However, it is through theories on identity formation (e.g. Tajfel, 1982, McAdams, 1990, Holland et al, 1998) that I hope to provide insight into the emotional and cognitive journeys they took.

Preliminary findings from the initial questionnaire

The pre-course questionnaire, Questionnaire A, was administered during the students' induction week, i.e. before they had been to any lectures or tutorials. At this point in the year, the cohort list had 142 names on it, and of these 123 students completed the questionnaire. Subsequently it was discovered that a few students had never enrolled i.e. they changed their mind before the course began, and others swapped courses within the university, or transferred to another university, or decided against full time education entirely, within the first few weeks of term. These students are not counted in the official figures as having "dropped out" as officially they were counted as never having started their degree course.

When asked what they were most looking forward to at university, roughly 50% of the respondents referred to meeting new people, making new friends and the social side of university life. Some typical responses were "Making friends", "Being around new people in the same situation as myself, getting through it and finding new mates" and "Meeting different people and establishing a good social life". This side of university life therefore far outweighed the 33% of students who responded in terms of their interest in mathematics, knowledge and learning. The need for a social

network of friends was uppermost in many of the students' minds before they had even started their degree course.

Another 10% made reference to looking forward to the independence and freedom of living away from home. Example responses are: "Getting away from home, being more independent", "Growing up and gaining independence". This is clearly akin to the autonomy, or agency, aspect of identity work referred to by Murphy (1990) and a sense of 'becoming' (Murphy & Hall, 2008), as well as being a component of "relatedness" (Alderfer, 1972).

Conversely, when asked what they were least looking forward to 10% replied in terms of being away from family and friends, another 10% having to cope financially, and another 10% having to looking after themselves domestically (in terms of cooking, cleaning, laundry etc). 38% of the students were least looking forward to the academic side of things; exams, heavy workloads and coursework.

These responses lead me to preliminary conclusions about students placing greater emphasis on their need to make social connections in the early stages of their time at university, more so than their desire to do well academically. This snapshot of the cohort's pre-course anxieties and concerns highlighted issues that required further research, and I turn now to the interview data gathered over the three years of the students' degree course.

Findings from the students' interviews

For most students going to university is a period of huge change and upheaval in their lives, and not only in terms of their academic studies. Many are experiencing separation (Tinto, 1993, Elkins, 2000) from their family and friends for the first time, and having to take on the responsibilities involved with fending for themselves. There aren't many other periods in a person's life when so many changes all occur at the same time, and for many of the students this is the first.

This separation impacted on the students in this study in terms of their apparent need to satisfy their "relatedness" deficiency need (Alderfer, 1972) which they articulated

as a desire to seek out others, in the new communities they found themselves in, to form social connections with and gain social support. They were highly motivated to form new friendships when they first arrived at university, and indeed through much of their first year, but their anxieties relating to these social groupings featured heavily in their interviews – both at the time, and again when they reflected on this period when being interviewed in their third year. In turn this process of meeting and categorising groups of other students forced a lot of identity work upon them working out which ones they did and didn't belong to, while at the same time trying to find out who they were as individuals. They were all trying to establish their identity within various new groups within the university setting, and to see how they fitted in.

For many their "sense of belonging" to these different groups was challenged throughout their time at university, but especially in their first year, and this impacted upon their self-esteem and confidence, both with their subject area and socially. As already discussed in Chapter 5, Solomon (2007) wrote about undergraduates feeling marginalised from the mathematics they were studying, but equally the students in this study often felt marginalised from the different groups, or communities, they encountered. It is the problem of finding both social support (becoming informally socially integrated) within their peer groups, and the ways the different students in this study went about approaching this problem that I address in this chapter.

When interviewing the students I asked them questions in terms of their "friendships" with other students, and how they felt they were "fitting into" their department, for example. This terminology I felt more attuned to the on going conversational style of interviewing that I used, and elicited responses from the students that I feel were more 'natural' as a result.

When I came to analysing the interview data I started by collating all the quotes I could find relating to the students' interactions with their peers and staff across the three years. This meant working my way through all the rounds of interviews for each of the students. Once I felt that I had exhausted this process it struck me that their social and academic interactions, although in many ways linked, were in fact too much to cover in one chapter. At this stage I decided to split my analysis between

these two categories, hence this chapter covering primarily their social interactions and Chapter 7 their academic interactions.

Narrowing down my focus to just those quotes relating to the interviewees social interactions, I turned my attention to where the students' social interactions took place and found that three categories emerged in terms of location i.e. their accommodation, their department/s, and the wider university community. This initial sorting also highlighted a longitudinal aspect of their social interactions, in terms of time frames of when the students focused on each category. I next focused on each of these location categories in turn, looking at how the interviewees spoke about different groups of peers and in terms of Tajfel and Turner's social identity theory (1979) and whether they considered them as "in groups" or "out groups".

All of the students interviewed spoke about wanting to "make friends" in some way with other students. While both the means they went about this, and the extent to which they spoke about it differed as much as their personalities did, the interviewees did all discuss it with me, both at the first couple of interviews, as well as when they reflected on the first year later on. One student in her third year spoke about the concerns she'd had during her first year at university,

> The most important thing, when you got there was to find people. I spent time worrying, does someone like me, or someone not like me, and what group did I like best and who I was going to live with. Even then, I was already worrying who I was going to live with in the second year. And trying to mix course friends with regular friends, they just wouldn't mix at all, so I can remember being sort of, like, torn, "*nobody wants to go out with me, they don't like me*" I just worried the whole time …, it wasn't worry about the work, I was just worried about settling in and what other people thought of me. [Jane]

As discussed by Brown & Rodd (2003), undergraduates join more than just the academic community of a mathematics department when they start their degree, they enter the wider institution of the university. They also become members of other communities during their time at university for example by living in a hall of residence or joining clubs or societies. As already mentioned, in the following data analysis I discuss how the students I interviewed spoke about the overlapping groups, and how they used them for support during the three years of this study. I do this from the perspective of their identity as members within these groups and as

individuals, with reference to the theories outlined above. I present my analysis by showing how these students dealt with the issues that arose, sometimes in similar, and sometimes in very different ways.

As the students moved through the three years of their degree different contexts played a part in their forming and developing friendships. As we will see, for many the period of most significant change occurred during the first term of their first year, but they also spoke about how their relationships with their peers changed over the whole period of their degree.

In presenting the interview data it must be noted that not all of the ten students interviewed spoke in detail, or in some cases at all, about each of the three main location categories I chose to focus on, in terms of social support. As discussed above, the process of initial open coding was followed by a several reviews where these codes were sorted, sometimes combined and then resorted, meaning that there were not quotes from all of the students under each of the three categories. In other words, the quotes used throughout this chapter were the only ones found in the interviews that fell under the categories I chose to focus on when looking at social support. Table 6.1 shows which of the students spoke about which category.

However, I will here address those obvious gaps in data, highlighted by Table 6.1 on the next page, in more detail to enable the reader to form a better picture overall of the students involved. It can be seen there are no quotes from Adam used in this chapter. The reason for this is two-fold. Firstly, as already noted in Chapter 2, much of his interview data was lost due to a technical problem with the recording equipment the only time he was interviewed, during his third year. However, from memory, he also did not speak much about these issues. Adam was a mature student living with his girlfriend. He had been to university straight from school to study Chemistry but had dropped out part way through his degree. Having spent a few years doing decorating to pay his bills he had decided to embark on a mathematics degree, something he felt in retrospect he should have chosen to study. During his one interview, in his 3rd year, I did not get the impression that getting to know other students had been a particular problem for him, or at least he had not worried about it in the way that most of the other students interviewed had.

Name	Accommodation		Student's department	Wider institution
	Living with other students	Living at home		
James	√		√	√
Lyn	√		√	√
Hakim	√		√	√
Rafik		√	√	√
Sarah	√		√	
Yen			√	
Steve		√	√	
Jane	√			
Charlotte	√		√	√
Adam				

Table 6.1: Interviewed students' contributions to the sections in this chapter

Then there is Yen, who did not speak at any length about living with other students. She came across as quite shy in interviews and was particularly quiet in the two focus group interviews in which she took part. Although she did open up more when interviewed individually, she didn't tend to offer up her opinion on her experiences. Also, she had shared a room in a hall of residence in her first year with a friend from school, so maybe didn't feel as much pressure to make new friends in the first few weeks as some of the other students.

Jane also did not focus on getting to know students within her two departments, Mathematics and Physics and Astronomy. She mainly focussed on the stresses of living in a hall of residence. Jane was also very softly spoken, so much so that parts of her interviews were inaudible on replaying.

In the final category, where the students spoke about their involvement in the wider institution, it can be seen that only five out the ten students spoke in any detail. As will be seen later in my discussion and conclusions these gaps in the data actually helped to highlight that Van Gennep's rites of passage do not apply for all of the students in this study.

Living with other students

Most of the students interviewed lived in a hall of residence in their first year, and for some it was their first time of living away from their home and family. Being in such

close proximity to a large group of strangers initially brought out many worries in terms of their sense of belonging. Insecurities about "fitting in" and "making friends" were spoken about by all of those interviewed, even the ones who came across as overtly confident. Most of the students did make some friends in their hall of residence, or were on friendly terms with the other students, but many had the impression that they weren't part of the "in-crowd".

Those students who found living with lots of other students particularly difficult spoke about feeling uncomfortable around specific groups of students they termed as "popular" or "cool". Jane, for example, lived in a large self-catering hall of residence and spoke about a particular group of students who she felt she didn't have anything in common with, and was nervous to be around.

> Things like going down to things like breakfast every now and then, the "cool group" would be there. A lot of my friends, they would never come down for breakfast, but I would always . . . I didn't know anyone, so I didn't know where to sit, and it would make me worry. [Jane]

She expressed the term "cool" here in an almost derogatory way. She disassociated herself from this group, referring to "my friends" as completely separate from them. In terms of Tajfel and Turner's social identity theory (1979) this "cool" group is an outgroup to Jane, but in the sense that she uses the word "cool" it is obviously not something she aspires to. This group is not one she wants to make friends with and they even make her time living in the hall of residence a less enjoyable experience, not by doing anything overtly to upset Jane, but just by making her uncomfortable.

Similarly Sarah found that there was a group of students in her hall of residence that she did not mix with. Again they could be considered the "cool" group, in that they were seen to socialise a lot, and again to Sarah were an outgroup. She made reference to them in terms of them lessening her enjoyment of living in the hall of residence.

> All the people on the floor there, none of them were doing a similar course to me, they were all, like, different, because I'm, like, more quiet, but all the people on my floor, they like going out every night, drinking and everything, so I didn't really get on with them, so I think that's one of the reasons I didn't like it. [Sarah]

Interestingly Sarah makes mention of the fact that although it bothered her she didn't think those students in the group would have thought about it. She projects this lack of compassion on to the "outgroup" to boost her self esteem as a non-member.

> I think about it, but you know, they probably wouldn't think about it. [Sarah]

Again, like Jane's experiences at breakfast time in her hall of residence, this group made Sarah feel uncomfortable to be around, and it obviously became an issue for her to use the communal kitchen.

> But, yeah, it just felt a bit awkward. Something like, if they were all sitting in the kitchen and, like, I went in there and they were talking, like, they'd stop talking or something, just things like that. I wouldn't feel comfortable. I didn't feel comfortable going in, like, the kitchen, when everyone was there. I didn't have a lot in common with the people. [Sarah]

Not fitting in with many of the other students in her hall of residence led to her going home to her parents' house quite often at weekends at the start. However, as the first year progressed she resorted to going home at weekends less and less. Part way through her second term she spoke about it again.

> Yeah, well, near the beginning I think I used to go back once every two or three weeks, but now I think I'm . . well I haven't been back for four weeks. Yeah, most people from my halls would go home at weekends, so it was quite quiet. It was also a bit of a hassle, packing my bags and going on a train. I tended to do less work, as well, so I prefer to stay here and get my work done. Yeah, I'm quite used to it now, I haven't been back since I came back from Christmas. [Sarah]

This was Sarah's first time of living away from home. When she spoke again about this period, during an interview in her third year, she expressed how much of an impact living in a hall of residence had on her. In particular she mentioned the first weekend she arrived.

> Because it was, like, so different, because I'd never been somewhere like that before, that's like the first thing, living there. When I think about the first term, that's the first thing I think of, when I first got to Halls of Residence and, like, living there the first weekend, like, I didn't like it, because I was on my own. [Sarah]

and went on to reflect how she had clearly struggled initially but that the comfort and familiarity of her family helped her to cope during the first term.

> Probably near the beginning it was like homesick, yeah, and I prefer – I think, more near the end, probably I preferred being at home, with the facilities at home. If I didn't, like, get on with the people there, as well, at least when I went home I got on with the people. Like, it was, you know, a nice bathroom, so it was probably more to do with that. [Sarah]

Charlotte arrived two weeks before most of the other students who were living in her hall of residence, as she attended the Mathematics bridging course before term started. She told me about what then happened the weekend before the beginning of term, when most the other students moved into the hall of residence.

> When the rest of them came down, the people on my floor were like the popular people, and I'm not really one of them, so I didn't really fit in with all the rest of them around. [Charlotte]

Charlotte refers to this group in terms of popularity much in the way that Jane refers to the "cool" group and Sarah those "going out every night, drinking and everything". Again she disassociates herself from them in terms of things they did, and categorises herself as from a different group

> Well, they were all like people who smoke a lot, do drugs a bit, go out drinking every night, don't get back 'til really late. And I'm not really one of those. [Charlotte]

She did find other students in her hall that she got on with and gained some social support from.

> But, there were some other girls living in a different part of it, and they were really friendly and we got quite close. One of them was in her final year, so, I never got to see her again. She was really helpful, it's nice to have someone to talk to who already knew everything. [Charlotte]

I only interviewed Charlotte once, in her third year of studying, and she came across as friendly and chatty, but disillusioned with her time at university. She spoke a lot about the boyfriend she had met before coming to university, and the fact that she spent most weekends with him, which would mean her going to visit him where he was studying, or him coming to visit her in London, or them both meeting up back at

their parents' home town. Although Charlotte did make friends during her first year in the hall of residence she didn't manage to keep in contact with them, possibly because of the fact that she didn't spend the weekends socialising with them, and actually spoke more about the group of students who she felt she didn't fit in with.

> Because, I don't know, I sort of lost touch with the original set of friends that I'd made, I just – especially towards the end of the first year… it was quite a down period, I just ended up being quite isolated when I was there. The people, after they've been there for nearly a year or whatever, they were getting more confident, … they smoked in common areas. They were making more noise. At the beginning, we got the occasional fire alarm, towards the end it was like every day, sometimes it was in the middle of the night. Especially if you're having an exam, that was such a pain. It was really distracting. [Charlotte]

The students quoted so far have categorised outgroups of students in their halls of residence in terms of them being "cool" and going out socialising all the time. While none of them appeared to want to belong to these groups, the terminology they used I felt revealed an underlying anxiety in terms of some insecurity in their own popularity. Other interviewees also spoke about not fitting in with other students in their halls of residence, but seemed less worried about it than those already discussed above. Hakim, for example, lived in a catered hall in his first year and although he didn't speak much about it while he was there, he reflected upon his time in halls in his third year. As with the students already discussed above, he felt that he was never really a member of a group within his hall of residence. He discussed them as being an outgroup while one of his ingroups was within his department.

> So, yeah, I mean, the people in my hall I thought were probably OK. I wouldn't say that I became friends with them but it was on a friendly basis, that some of them I talked to. I still see them from time to time and say hello. So, things were OK, but I was never really in their group. I guess it's just the fact that you form your own group. I guess they had their group and I was in a different group, which happened to be at the department, and somehow I wasn't mixing with them. [Hakim]

James also lived in a catered hall of residence in his first year. In contrast to Jane and Sarah, he found meal times a social occasion, and was happy to move between groups to try to find the social interactions he was looking for.

> Well, obviously, right at the start of term, you're hauling yourself around, trying to meet as many people as possible. Starting from last term, I hang out with a

> bunch of people for a couple of weeks, went away from them because they weren't very interesting, find some other people, they're a bit quirky, most of them have become good friends in the long run. It's very rare you find someone who's going to be a good friend in the long run. It's a support network, you know, people to talk to at dinner. Dinner's the greatest social time, and breakfast, that's about an hour an evening. [James]

For Hakim and James it wasn't their first time of living away from home. James had an enforced gap year before starting his degree course, due to not being accepted on to the courses he had wanted to study in America, and so had worked abroad and travelled. Hakim also did not have the "traditional" background of studying A levels and then going straight to university. He had studied the International Baccalaureate at the European school in Brussels. Lyn also had not come to university straight from taking her A levels as she had chosen to take a gap year and go travelling. Maybe as a result these three students spoke much more about their disappointment in other student's immaturity, compared to the other students I interviewed.

Lyn for example spoke at length about living in the room next to the hall of residence common room and being kept awake at night by other students. In her third year when she looked back on her first year living in halls she brought it up again as something that had been an annoyance at the time.

> It wasn't a major part of my life, it was more of, I don't know, I just had to put up with it. It was seriously a hell of a lot of aggro, and I'm probably in the minority in saying that but it was because I was right next to the common room, so I was woken up all hours of the night. I would hear all the arguments in the corridors, like, even if the TV was on, I couldn't sleep, people would play piano or whatever. [Lyn]

Lyn found some of the behaviour of other students annoying and immature. She told me about an incident with a small group of students letting off one of the fire extinguishers under her door one night, and the whole floor getting in trouble for it and being fined.

> But, yeah, it was alright, I've kept in contact with a few people from halls, but, I don't know, I think it maybe it was the people that were there, a lot of them were very two-faced and quite immature, whereas I've got a lot of my friends – my other friends, who've lived in halls, and so much nicer, easy going. [Lyn]

However, she also seemed to make enough friends that she had the social support that she needed, in the form of the company of others.

> But, saying that, it was also nice because it meant, like, you know, if I just wanted a break I could just go and talk to people, I could go and sit with people, I could watch a video with people, do you know what I mean? And that was really nice. Or even just go out with people, there was always someone going out, so it was really nice to just be able to, "Oh, I can't face work, right, let's go out," and there'd always be someone up for going out. So, in that respect, it was good. [Lyn]

James was also particularly vocal about his disappointment in the majority of other students he met. He had spent his gap year working in Armenia on a regional development programme, which no doubt added to his feeling of being more mature than many of the other students.

> It's like being back at school. School's awful, full of children. Ditto. I've met a few people who I get on with, we have good conversations, but the vast majority of people, it's the 'let's get pissed' culture. And I've nothing against that, but I got it out of my system when I was a kid. It always makes people laugh when I say I went teetotal when I was sixteen and a half. I mean, that's the thing, you come here and you encounter this whole attitude that does seem very juvenile and it irritates me somewhat, because it's just not constructive. I can't say I'm having a wonderful time here. I'll probably stick it out just because there's a lack of other options. The whole education system is designed to channel people to go to university. [James]

Hakim also found some of the students in the hall of residence immature, mentioning that some of them were playing football in the corridor at midnight. He also had an experience with one individual that made him wary of meeting others.

> Yeah, I don't know, I didn't really – I mean, there were some, I don't know, I just found them very weird, There was one guy, this crazy guy, he found out I was, like, half-Pakistani. I was sitting down eating, and he was talking to some other guy, and somehow I joined in. And then, I don't know, I found out he was some sort of Taliban sympathiser or something, and I was just trying to stay as far away from him as possible. He came and knocked on my door and asked me about stuff, so I just had to – I mean, I didn't tell him to get lost, but he kind of got the message. So, that was kind of a bad experience, I found I was a bit worried of meeting any people, they just seemed really strange people. [Hakim]

Moving into a hall of residence threw these students into mixing with a lot of new people all at once, in unfamiliar surroundings, and the significant amount of identity work involved initially in categorising ingroups and outgroups is evident from their

interviews, both at the time, and on reflection. Amongst those interviewed there appeared to be a contrast though between those students who had lived away from home previously and those for whom this was their first time of separation from family and friends. This was not in terms of their developing a sense of belonging within their new environment, but more their confidence, in that they appeared less anxious about fitting in with the "in crowd". Those that had already been through a separation phase previously had maybe gained more autonomy from these prior experiences and seemed less worried about what others thought of them.

In the second year all the students who had been living in halls of residence moved into rented accommodation. Many of them expressed that this was a relief in terms of the social aspect, in that they had chosen the friends to live with. The main focus for most of them when talking about their accommodation was complaints about the practicalities of renting property. Maintenance of the accommodation, infestations of mice, hassle from the landlord in terms of payment of rent, were all mentioned.

That's not to say that some of them didn't have disagreements with their flatmates, but the predominant first year anxiety they'd spoken about in terms of fitting in with others, and the discussion of outgroups and ingroups, was much less prevalent than in their first year. Sarah in particular seemed so much happier once she had moved out of the hall of residence she had been in during the first year. She lived with other students in a shared rented flat in her second year, including Yen who was on the same course. Sarah spoke about this period in terms of her freedom to do her own thing without having to worry about other people, as she clearly had when living in a hall of residence surrounded by students she categorised in outgroups.

> Yeah, I much prefer living in a house than in halls. Yeah, I think when I was in halls, I probably did want to go home more. But when I'm in a house, I can just do what I want, so that's fine living there, I don't mind being on my own, either, . . . , so it's OK. And over the holidays, I wanted to stay here, because it's quieter to do work, so I think that was good. It's probably the people, for me. Because I didn't know everyone on my floor. . . like, in the kitchen, I'm quite shy, so if there's loads of people there that I don't really know, I wouldn't be comfortable with just cooking and just sitting there. It's just like your own house, you can just do what you want, you don't have to worry about other people or anything. [Sarah]

Despite not enjoying her experience of living in a hall of residence, by her third year Sarah did reflect on her time living away from home as being a positive thing overall, in terms of developing her autonomy and confidence.

> It was good in terms of living away from home, because I'd never, like, lived away from home and now, like, I'm used to it, now I can just stay away from home for a long time and I am more independent. I didn't like Halls of Residence, though, it's put me off them, like, I wouldn't want to go back into them, really. [Sarah]

Although there was still identity work taking place during the students' second and third years in terms of their living arrangements, and their dealings with housemates, landlords and letting agents, the students spoke much less about their anxiety in relation to these experiences. Despite the many and varied problems that renting somewhere to live dealt them, for most of the students interviewed these difficulties were made easier to cope with by the social support of the other students they had chosen to live with.

Living at home

Rafik and Steve both lived at home during their degree and commuted to university on public transport. They were torn between wanting to make friends at university but not breaking away entirely from their friends and family from home, and both articulated pros and cons to their living situations at different times during the three years of their degree course.

Rafik, who is Muslim, in particular spoke about the support he gained from his parents, during this period of "separation" from his previous community of family and friends, and made reference to his strong family ties.

> I think I'd rather live at home than at halls, because, obviously, my parents are there, if I have any problem I can talk straight to my parents, they're really understanding, as well. And my little brother, I help him out with his GCSE Maths. [Rafik]

Rafik also reflected on it again in his third year when interviewed about what had influenced him most at different times during the three years.

> The reason I picked living at home, 'cause it played a really important role for me because, basically, I need my parents there to give me that push. And during the first term I was finding it quite difficult settling in. They really were there to support me and push me through, whereas if I lived around university, I don't think I would have had that. So, that was really important to me. [Rafik]

He also had other ties to his parental home, in terms of friends who still lived nearby.

> Yeah, I'm part of a musical band, so I always see my friends when we go to rehearse all the stuff. And, yeah, I like to meet up with my old friends, because I've spent most of my life with them. [Rafik]

However, he did voice his reservations about whether living at home affected his ability to make friends at university early on. Possibly due to his religious beliefs he didn't feel entirely comfortable with some of the socialising that other students did. Maybe the easier option for Rafik was to continue to socialise with his friends from home, as it meant he didn't have to conform to the "stereotypical" student life of going out partying and drinking.

> Yeah, that does play on my mind quite a bit, because you hear people talking about they went to a club and stuff. Half of me is saying, do I really want to do that? The other half of me is saying I should do because it's part of growing up. But, deep down, I don't think I really want to fit into that scene just yet, I'd rather just stay out of it. [Rafik]

Much as he wanted to fit in at university and make new friends he struggled during his first term there. When he reflected on that period during his third year he mentioned feeling very lonely at the time. Then at the start of the second term, when the students had mid-sessional tests for their maths modules, Rafik felt that he had done really badly in the first one he took.

> I think it was just the fact that it was the first exam, and the first exam that I've ever had at university, and I was a bit nervous and I started to panic. [Rafik]

Afterwards he said he had been "distraught" and even considered leaving the course. His parents had been really supportive and persuaded him to stay and take the other two tests. It is possible that if he hadn't been living at home he would have dropped out of his course at this point, and the importance of the influence of other communities which some of these students simultaneously inhabit should not be underestimated. As Wilcox et al (2005) concluded in their study with undergraduates,

> "In this early stage, before students establish new friendships, emotional support from family and friends at home can act as a buffer against the stress of feeling alone in a strange environment". p. 713

By the second year things had changed for Rafik though. He still saw his friends from home but had also made good friends with other students on his course that he socialised with during the week. He was one of only ten students studying Mathematics and Physics as a joint honours degree, and as will become apparent they became quite a close knit group.

> After lectures, I usually just hang about with people I know from here but, very rarely, after I've finished the day, do I meet up with my friends from my area. It's late, so I usually leave that until the weekend. Every weekend, if I have the time, I just like to meet up with them, . . . do activities like go watch a film or something. [Rafik]

Steve also lived at home during his degree, and admitted that he relied heavily on his mother for support domestically. Although he acknowledged that he was "just too lazy to move out at the minute" he did appreciate her for this.

> Yeah, my mum does everything for me, still. And, yeah, she's really good to me, so, I have to sing her praises, really. [Steve]

He differed from Rafik though in that he happily joined in with evening social activities with other students from early on. Some of his friends from home were also studying at the same university, and other at universities nearby, so in his first year he didn't feel he was missing out.

> It hasn't really been that much of a problem. Luckily, I've got some mates who don't really mind me just crashing on their floor, so it hasn't been that much of a problem. One of my mates is in a hall of residence just across the road, anyway. [Steve]

Nearing the end of the second year Steve was in two minds as to what to do the year after in terms of accommodation. He didn't want to apply for a place in a hall of residence because he was worried about it being full of first years and that he'd be the "odd one out" with them all "just going mad, and I'm trying to get on with work".

He thought it more likely that he'd look to rent somewhere privately with some friends.

As it turned out he stayed living at home during his third year, and when he reflected on this decision near the end of his degree, he firstly spoke about what he felt the positive outcomes of doing so were.

> In retrospect, I probably might have, you know, gone into halls. However, it has saved me a lot of money and stuff and my results were probably better staying at home. [Steve]

He also thought that living at home had given him the advantage of being able to distance himself from the socialising, something he viewed as being a distraction for those in halls of residence.

> You see everything from more distant perspective rather than getting immersed in. I know people – one of my really good mates – he went out of halls and had a brilliant time but didn't do any work. And you really live that experience, you get immersed in it and, I don't know, some people just can't take it and I'm probably one of those people. I mean, I don't know, I haven't done it, but it's definitely a perspective thing. You can say, "No, I can't go out tonight, but if you're in the halls and everyone else is going out, you can't say no. [Steve]

However, he did acknowledge that in living at home the whole time he hadn't fully made the break from his past and his family ties, and spoke about it in terms of his own autonomy.

> Yeah, I mean, the way I played it, is an extension of school, I mean, there's no two ways about it. I haven't lived the university experience, particularly. I've got a lot out of it but I haven't done what a lot of other people have done, you know, I wish I'd learned to cook, and I would have done by now if I had lived in halls and stuff. [Steve]

He also emphasised what he saw as the importance of the social support, and his perception that some students made more friends from being in a hall of residence.

> But you do need a lot of people, just generally. Most of the people I keep in contact with are still the people on the course. But I know a lot of people from halls, that I haven't met through my course now. Some people need to have that environment, just to chuck themselves in, 'cause they won't make friends

> otherwise. I don't like to think it's a big mistake on my part, I wouldn't say you definitely have to go to halls to make friends, but, yeah, I think it helps. [Steve]

but then went on to say that this is mostly an issue in the first year and that certainly by their third year it did not seem as important.

> I think there is a slight divide at the start but, in the third year, you don't even mention it now, to be honest. It's more, "Where do you live now?" So, I mean, most people are in flats or whatever now so, I wouldn't say it's a lasting divide, at all. [Steve]

As can be seen there are contrasts between Steve and Rafik in terms of their experiences and how they started to develop a sense of belonging. Steve initially threw himself into the student life more than Rafik in that he socialised with other friends of his that were living in halls of residence, and then also developed friendships and social support within the small group of joint honours students studying Mathematics and Physics, but ultimately felt that he hadn't fully lived the university experience. Rafik started his time at university feeling very lonely, but with the encouragement of his family and gradual build up of friendships amongst his peer group, soon fully appreciated the social support they all gave him. As will be seen later in this chapter, and the following one, Rafik ended up with a much stronger sense of belonging within the university as a whole than Steve did, despite his difficult first term.

By continuing to live at home during their degree these two students did not experience the phase of separation in such an acute way as those who had moved away from home for the first time, or even those for whom starting at university was not their first encounter with separation from family and friends. They did however still have anxieties about fitting in with others, but, as Elkins (2000) found, the support from their previous community i.e. family and friends, helped them to get through this initial separation phase.

The students' departments

As can be seen from the previous two sections, early on in their time at university the students focussed primarily on the social support provided by those that they were living with. This dominated their interview data and most of the students didn't talk

as much at the time about getting to know other students socially in their department, or departments in the case of those doing joint honours. What they did discuss however showed the considerable overlap between the social and academic aspects of the support that developed as they got to know their departmental peers. This was in terms of the way that their interactions so often revolved around them having the mathematics and their courses in common, and will be discussed in more detail in the next chapter, but was highlighted by Rafik nearing the end of the third year when asked about what he enjoyed most during his time at university.

> I think the sense of friendships and stuff. When you're doing the course, like, you're all in the course together, you're finding it difficult, and you really do feel like you've got people to turn to. And especially because maths and physics, there's only a few us, like we're really close, so I think that's what I – I mean, if I was trying to sell it to someone, I'd say you get a lot of good friendships from it, and from that, you can also learn a lot more about your course and your own studying techniques. [Rafik]

Of the students I interviewed during the three years, four of them, Rafik, Steve, Yen and Sarah, were all studying for a joint honours degree in Mathematics and Physics (as seen in Table 2.1). I interviewed these four students together as a group twice, once was our first ever meeting, then again in their second year, but at other times I interviewed each of them individually. It was apparent quite early on though that these students spent a lot of time together as a group, alongside six other students initially also studying this degree pathway. This was probably through necessity to begin with, since they took all the same courses, but later they all spoke fondly of each other and the support they gained from each other. In Year 2 Yen and Sarah even lived in a shared flat together, along with students from other courses that Yen had met in Year 1 when she lived in a hall of residence.

For Sarah who, as we saw, found it hard to make friends in her hall of residence, being part of this ready made small group of peers helped her to integrate socially.

> I suppose that's the next biggest thing, because when you go to university, you don't know anyone, so, like, I made all my friends, like, at uni, and I got on with them all because they're all, like, doing similar courses, they've all done similar things at school and everything, so I get on well with them. And it's kind of new for me, as well, because I'd gone to an all girls' school and I'd never really known any boys, but, like, now, I'm friends with some boys, as well. Before I thought I probably wouldn't get on with them, but I did. [Sarah]

The other two Mathematics and Physics joint honours students, Rafik and Steve, as already mentioned both lived at home for the whole the three years, and they spoke on various occasions about the pros and cons of this small group who were all enrolled on the same course. Rafik spoke about how he found it difficult to make, or maintain friendships with other students within the two departments, but again that they quickly developed a close bond amongst this small group of joint honours students.

> So, yeah, but, again, it did take me quite a while to find friends. I mean, you had all the maths people, they were all together, and physics, and, like, we were sort of the outsiders within both. And it was difficult for us - I mean, I made really close friendships with people doing maths and physics, but in terms of people doing straight maths or physics, it took me a while to actually get to know them. I mean, plus the courses were different, as well, sorry, the units. So, I mean, some of the friends that I made in straight maths, they'd be doing different units, I wouldn't be able to establish that relationship. [Rafik]

Nearing the end of the first year, when I asked Rafik how he thought his friendships with other students had changed during the year, he spoke again really positively about how the friendships within this small group were developing.

> I think there's a lot more trust now. Before it was just a hello or goodbye basis but now if we have problems we can talk to each other about them. And I think that's how they developed in that sense. If I had a really serious problem, I don't think I would probably – well, I'd maybe tell a couple of people but I'd still keep it to myself to that point, but that'll probably change in the next couple of months, hopefully. [Rafik]

Steve also made reference to forming stronger bonds with this group than with other students in the mathematics department.

> To be honest, I'm with the same group of people that I met, most of them are doing Maths-Physics. I think I met a few more people doing other joint subjects or just Maths, and I haven't spoken to them as much. It's tended to be the ones – in doing Maths-Physics, we've got a lot stronger relationships now, and the ones, you know, when you meet – because for the first week, you haven't got any – there's no distinction between people, everyone was a Maths student, and we just went around together. But since it's gone on, I think the friendships have become, between the Maths-Physics, the strongest ones, anyway. But there's not a lot of change, mostly the same people. [Steve]

However, for Rafik, this "safety net" of a small group of peers on the same course, also ended up having its limitations. Nearing the end of his second year he spoke

about how he was keen to make new friends outside of this small group, and again in his third year he felt the same, even seeking out a third year course he felt the others from this small group would not be choosing,

> This term, I didn't really have much of a choice, so I picked basically the courses which everyone else had picked. Next term, I'll pick courses which hardly anyone is doing, like I picked History of Maths, which, as far as I know, no one else is doing. [Rafik]

I'll discuss this group again in the next chapter in terms of how they also supported each other academically.

This close social bond did not necessarily develop for all the groups of students taking a joint honours degree course. A couple of the other interviewees were also initially enrolled on joint honours courses but ended up swapping to studying single honours mathematics during their first year. Lyn was enrolled on the Mathematics and Management course to start with, but struggled with the essay writing so swapped to straight Maths after a term, and Hakim was originally taking Mathematics and Computer Science, but found he didn't enjoy the programming aspect of computing, and he therefore swapped to single honours Maths after a term too.

For Lyn and Hakim it wasn't then until during their second year that they really started to speak about feeling that they had properly developed friendships with some of their peers in the department. Lyn for example spoke about one of the difficulties of developing friendships with other mathematics students the year before by making mention of the sheer size of the department and her cohort. Again this is something I will discuss in more detail in Chapter 7.

> There were only a few people that I really got to know and the rest of them… it's just so big. [Lyn]

Hakim in his second year said,

> I think I've still got the same friends as I did before, but now I have more. I've still got two or three friends in the computer science department, another one is my flatmate, so these are people I knew last year. And this year, well, I've kind of met five or six new people that I consider to be friends. [Hakim]

but then reflected in his third year on how his friendships had developed over time.

> Yeah, friendships. I mean, I made friends in the first year, obviously, but I probably made the most friends in the second year. People I vaguely knew in the first year kind of really became friends, and that's why I really got a large group of people that are friends, and people I still know now, so that was the most important. So, that's why I kind of left it out on the first year because, although I met some friends and some half friends, they weren't really what I'd call friends yet. [Hakim]

Friendships did not develop in the same way for James as they did for many of the others I interviewed, and he certainly stood out in terms of his attitude towards his peers. As already discussed, from early on he was very disdainful of the majority of the other students he'd met, and this continued, more so than any of the other students interviewed. Although he had felt the need to try to make friends initially, as discussed in the previous section, he soon came to the conclusion that he had little in common with most of the other students, and was resigned to this.

> Most of them are associates rather than friends. But, sure, I have a few drinks with them and they'll phone me up and perhaps invite me to parties or whatever. I don't know, I don't feel I developed any close bonds with anyone, even with my girlfriend, it was a while before… But, no, there's no one, really very few people on my wavelength, at all. It's not something really to complain too much about, but, again, they're just so young, they still are, it's deeply unimpressive. And it's just what you live with, you get used to it after a while. [James]

By his third year James was even more resigned to the fact that he had not made friends with many of the other Mathematics students. When asked about it he replied,

> I see people within the maths department. I'm sure some people I could develop a greater friendship with. A lot of it's being given the opportunity. I mean, there are a few people I know I could be friends with, within the maths department, just within my year, probably about three people who I could be good friends with. It's just opportunity and effort and finding the time. Especially this term, there's people I haven't seen all term just because of our timetables, so it's quite strange. I might become better friends with some of these people once I leave university, because anyone I keep in contact with you can then classify as a friend rather than as a passing acquaintance. And I'll try and keep in contact with maybe about three. I don't identify myself with the community. But this applies to my entire university career, anyway, I don't go out with a group of friends, as such, whereas most people do. And I'm not good on the tribal thing. [James]

James's own sense of identity was more clearly defined with him as an individual rather than as a member of any groups. Coming to university had not been a great leap in terms of developing independence, in the way that it maybe was for others, and he clearly felt he was mature beyond his years. However, other than his continued disappointment with the maturity level of his peers, this lack of a clearly defined friendship group and its accompanying social support appeared to have no detrimental effect on James in terms of his academic attainment. This is contrary to other literature e.g. Eggens, 2007, that found that both social and academic integration positively influence study attainment.

In contrast I feel it is worth mentioning Charlotte again here. She became more and more isolated during her time at university, losing many of the friends she made in her first year when they failed to complete their first year.

> In my first year, right at the beginning, I made some quite good friends, but then a lot of them dropped out. [Charlotte]

Charlotte clearly found her time at university tough, and this seemed to be due in part to her lack of social integration. As already discussed she lost contact with many of the students she met while living in a hall of residence during her first year, and as we now see many of the mathematics students she had become friends with struggled so much with the work that they dropped out. Her small social support network had therefore pretty much disappeared by the end of her first year.

In her second and third year having no established friends to flat share with she moved into a flat with her father, who worked long hours and was therefore not around much. Her focus for social support seemed to primarily be her boyfriend who was studying at a university in another city, so although he provided encouragement in terms of her completing her degree being a good thing for her to do, she had no social support within her department to help her achieve this. By her third year she seemed to only interact with other students in her department in terms of a small amount of academic support she could gain from them rather than for any social support, but I will discuss this further in Chapter 7.

The relationships that some of these students formed with their departmental peers took time to fully establish in terms of the social support they provided, and some even felt that it wasn't until their second year that they could describe them as real friends. For some of joint honours students though having the consistency of being within a small group helped them to bond more quickly, and this clearly continued to be the case throughout the three years of their degree.

In the wider institution

Developing a sense of belonging was clearly an on going process for these students, and some actively chose to become more involved in their department by becoming volunteers. One scheme they could become involved with was Peer Assisted Learning (PAL) but none of those interviewed put themselves forward for this. Hakim, however, did volunteer to be on the staff-student committee for the mathematics department.

> Also, this is once a term, I'm kind of the year representative, I sit at this thing and we discuss any problems for the year, whatever. [Hakim]

> I mean, it was kind of just selfish reasons. I just wanted to see how the inner workings of the whole thing were, really, the kind of politics of it, in some way, or to get an insight. [Hakim]

During their second and third years of studying many of the interviewees also volunteered within the wider community of the university on various schemes within the institution. As well as being on the staff student committee Hakim volunteered to be a student ambassador, a role representing the university to the outside world. These volunteers show prospective students around the university campus, or go to secondary schools and speak to those pupils about to start applying to universities.

> It's every week students come in, most of the time. At the moment, you've got the Oxford/Cambridge people, who have to apply early, here, and then, later on, you'll get the other people. It's once a week. [Hakim]

Rafik appeared to find more enthusiasm for his time at university through becoming involved with several schemes organised by the widening participation programme. For Rafik these volunteer roles helped him to feel part of something bigger, as well

as enabling him to make new friends outside of his departments, all of which gave him much more of a sense of belonging to the university as a whole.

> I'm loving university life. I think the problem with me last year was that I wasn't get involved in anything, so I was coming to uni, I'd do the work and I'd go home. This year, I've got like the Student Ambassador Scheme, I've got the mentoring for tutoring, I've got the Music Summer School coming up, so I'm getting more involved in the university and the way it works, so I'm getting to meet some of the people that are at the top, type of thing. So it's a really nice feeling to know that they know you. [Rafik]

Lyn also did some voluntary work in her second year, both as a student ambassador,

> It was also as an ambassador, going round talking about student finances and stuff. [Lyn]

and a student tutor (the mentoring for tutoring that Rafik refers to) within a local school, helping out in mathematics lessons with the pupils. However she encountered administrative and organisational problems with that particular scheme both years that she put herself forward for it.

> I still haven't got a voluntary placement. What happened was, another problem, with the voluntary scheme. This time, he had my first email address, but my email account wasn't set up properly with the right server, so I wasn't receiving any emails. But, on Friday, this week, I'm going to a school in Islington, I'm being shown around a school, and hopefully I'll get a placement with them. [Lyn]

James, who appeared to have no real sense of belonging to his department, also volunteered to be a student tutor.

> Volunteer work, local school, Islington, very nice, good fun. A terrible school, absolutely appalling school, but the kids were nice. It was a girls' school, actually. The teacher – actually, the most depressing thing out of that whole field, is that it's a job that you would have to be a masochist to want to be a teacher in inner city London. I mean, I got nice – because it was an all girls' school. But that was good. [James]

When Charlotte found that she had some spare time on her hands, due to the way her second year courses were timetabled, she decided to do some volunteer work too. However she chose to do so for a charity, the Leukaemia Research Fund, which was organised through the Voluntary Services Unit (VSU), rather than something that was directly related to promoting mathematics or the university in general.

> It was such a good experience. I really, really enjoyed that. My timetable at the time was all squashed up so I had like, loads and loads of free time, and I was getting a bit bored and I thought, I need to do something else. It was Wednesday afternoon, every week, that was all. [Charlotte]

Charlotte clearly found the contrast of this work with her studying rewarding. As noted earlier in this chapter she was feeling isolated socially, and as will be discussed more fully in the next chapter struggling with her academic work. She was also having a hard time with her finances, so this volunteering kept her morale up on many different levels.

> It was nice to be given some work and actually be able to do it, … requires so much thought, that was good, as well. You're off doing work and having a bit more structure to the day, something like that. And I got a free lunch. … I was on a monthly travel card, so I'd already paid, so it was costing me nothing to get there but they were still giving me … expenses. . . . in my pocket. [Charlotte]

This volunteering didn't help her social integration in terms of university life, but it may well have given her enough of a confidence and financial boost to keep her motivated to continue with her degree, at a key time in her second year of studying when she could have so easily dropped out.

These students had many and varied reasons for getting involved with these different volunteering schemes within their department and university. Inquisitiveness, something to put on their C.V.s that looked impressive to future employers, and more altruistic reasons in that they wanted to show others what it meant to them to be a student in this department, or in this university. By putting themselves forward as representatives in this way though they were making a statement about who they had become during their time at university.

Discussion

In this chapter I believe that I have shown that social support is vitally important for many students during their time at university, and helps them to start to develop a sense of belonging. This has been done using the theories outlined, the research evidence presented (both the initial data from this particular cohort of students, and the follow up from the student interviews) and by reference to other empirical

research.

The students interviewed for this study were varied and diverse both in what they were looking for in terms of social support, as well as how they went about finding it. Their emotional reactions differed both from each other, and at different times during their three years of studying. However, they all spoke about feelings of anxiety, to lesser and greater extents, related to forming social bonds with other students, particularly during the first term of the first year.

This desire for support came through strongly from the data throughout their time at university and these students were clearly conveying their deficiency need (Maslow, 1943) of "relatedness" (Alderfer, 1972). However, this need was exacerbated by their initial "separation" (Van Gennep, 1960) from their previous community of family and friends, hence its prevalence early on in their degree. I refer here to the original text for these theories, as they are still relevant for this set of data, and are used in other research (e.g. Arnolds & Boshoff, 2002, Elkins et al, 2000). As a more recent article by Christie et al (2007) undertaken with a group of non-traditional undergraduate students states,

> "…being and becoming a university student is an intrinsically emotional process" p. 3

and that

> "…feeling of loss and dislocation are inherent to the students' experiences of entering university". p. 3

The initial data from the pre-course questionnaire had shown that, for the majority of this cohort of students, the thing they were most looking forward to was establishing themselves in the university community and forming new friendships. All the students I subsequently interviewed also spoke about wanting to initially find others just to talk to, and share their experiences with, and then gradually find those they could form friendships with, and the anxiety that this search sometimes caused them. These concerns are also exacerbated by the problems of large numbers of students in lectures, and halls of residence, which made it difficult for students to identify groups that they felt comfortable with, or even individuals they counted as "friendly faces".

In terms of separation from family and pre-existing social networks many of the students found this difficult to start with, and travelled home at weekends to ease the transition. As they settled more into their social groups in halls of residence and on their course, and received support from within these groups, they relied less and less on family and friends from home.

Conversely, those students who continued to live at home worried about the effect that doing so had on their initial social integration. They did however feel that they benefitted from the support of their family both emotionally and practically. This is in agreement with other recent research (Wilcox et al, 2005, and McQueen, 2009) in that pre-existing social networks of family and friends can help students adjust to the new social and academic environment of university life, but depends entirely on whether these pre-existing networks are positive towards the student's decision to go to university, study the particular course they have chosen etc.

There were also students for whom separation had occurred prior to them starting at university, through taking a gap year, or studying abroad. For these students the difficulties they faced in terms of integrating with other students were different again. They often felt more mature than their peers, and struggled to find other students they could relate to. They had already experienced independence in their lives and it led them to find many of the "typical student antics" immature and annoying.

Separation, in whatever form it occurred, was the primary cause of these students' need for social support and relating to others. Maslow's, and Alderfer's theories highlight this need as a priority for many of the students over and above their development needs of cognitive growth. I feel my data has shown that at a very fundamental level these students want to fill a basic deficiency need of relatedness, and this is shown initially in their desire to find other students to talk to and gain social support from. In trying to make these social connections, they are then forced to confront, and even reconstruct, their own identity. Key important changes in a person's life e.g. first starting work, having children, retirement, often force them to reassess their own identity, and as can be seen from these students' interviews, starting at university is just such an important life change.

In terms of their social identity we can see that most of these students struggled initially to become members of specific social groups. Those in halls of residence in particular spoke about not having anything in common with the "cool" students, and for all of them this became an "outgroup" as categorised by SIT (Tajfel & Turner, 1986). Many of them spoke about making these sort of choices about which groups they fitted in with, and such decisions about their identity were entirely forced upon them by the context of the new environment and people they found themselves mixing with both in halls of residence and their department. As already mentioned this identity work was particularly difficult for those students who had separated for the first time from family and established friendships. They were more focused on trying to work out which groups they belong to, than those who were still living at home, or those who had previously lived away from home and therefore already been forced to be independent.

By the student's second year of studying most of them started to feel more confident in their friendship groups within their department than they had during their first year, and in general I would say that they put less importance on social support as they move through their degree. They talked about it less and were much less anxious about it, whether they had developed good friendships or not. For many however their focus then shifted to needing more of a sense of belonging to their department, and they spoke more about their fellow mathematics students. This, I propose, is the "transition" stage of Van Gennep's rites of passage for movement of individuals between groups.

This finding is possibly in contrast to the Terenzini and Wright (1987) large scale study based in the USA, where they found academic integration more important than social integration in the first half of a student's degree, but is in keeping with Wilcox et al (2005) who found that social support emerged as a significant theme in their analysis of factors important in student retention during the first year at university. In particular, for those four students I interviewed who were all studying Mathematics and Physics, I found that them belonging to this small joint honours subset of their overall year group helped them to bond socially more quickly than some of the other students in this study did with students in the Mathematics department. This comparison will be explored further in my next chapter where academic integration

becomes the focus and therefore a fuller comparison can be made.

And finally I would argue that Van Gennep's third stage of his rites of passage, "incorporation", occurred more readily for those students who got involved with programmes such as the student ambassadors scheme. They felt fully integrated within the systems of the university and were therefore comfortable in representing themselves as student ambassadors to the "world" outside the university. They accepted and embraced their student identity, and wanted to encourage others to apply to study at the same university.

Conclusions

In this chapter I have focused on the social support these students spoke about and the development, or lack, of a sense of belonging during their degree course. The students appeared to move through three phases in terms of identification. Firstly identifying "out groups", then individuals, or groups of "friendly faces" within their halls of residence, and department (which will be investigated in more detail in Chapter 7) and finally within the institution overall through involvement in university wide programmes such as mentoring for schools, widening participation and student ambassadors. These three phases of identification are in keeping with the trajectory of the students' rites of passage, and although they do not map directly on to the three stages of separation, transition, and incorporation, they do follow the same pattern.

However, although Van Gennep's theory does help describe the trajectory of many students' movement into university life, it did not seem to fit for all of those I interviewed. For example, some of the students interviewed never appeared to reach the incorporation stage. This becomes even more apparent in the next chapter where I focus on the academic support and will be discussed further there. Also, Van Gennep's theory did not help me to convey the richness of the data in terms of the development of the students' identities and their emotional journeys. In fact none of the theories I've presented were sufficient on their own to help fully explain the empirical data. Each one illuminates patterns in the data in different ways, and taking a somewhat eclectic approach to a theoretical stance has enabled me to highlight

these different aspects of my data.

The predominance of the social nature of these students' anxieties during their three years brought with it a realisation for me that support and developing a sense of belonging were key to their attitudes towards their time at university, and ultimately at some level towards mathematics. This was touched upon in the SEUM findings both in terms of the extent to which students felt part of a mathematical community, and them being able to share their ideas and problems with other students. These experiences had contributed to building positive attitudes to mathematics as an academic discipline amongst the students in their study.

In the next chapter I therefore turn my attention towards the academic support these students look for on entering their department, and again investigate the trajectories of the students interviewed and how they are affected by the relationships they form with their peers they encounter in this context, and this time members of academic staff also. By doing so I hope to discover more about the students' transition stage of the rites of passage and why some never reach the incorporation stage.

Chapter 7: Academic support and identity

Introduction

Looking at social support in terms of these students' sense of belonging and informal social integration (Severiens & Schmidt, 2009) in isolation from the academic aspects of their time at university was quite deliberate in the previous chapter. Their views on the social interaction with their peers had at many times dominated the interviews and therefore deserved further investigation. However, in doing so I had to, in effect, ignore other influences on their identity.

This chapter will therefore reintroduce two other aspects of their university experience, both in terms of the academic context of their department. These being: their interaction with peers relating to study, defined in the previous chapter as students' formal social integration (Severiens & Schmidt, 2009), and their interaction with staff related to study, defined as formal academic integration (Severiens & Schmidt (2009).

I have combined these within this chapter, as I feel they both relate to the student's identities in terms of them specifically being mathematics students, and therefore their academic identity. The students I interviewed spoke very little in terms of informal academic integration (interaction with staff relating to personal matters), which in itself might say something about student - staff relations in this department.

In this chapter however I move away from the theoretical perspective of social and academic integration, found in much of the literature about undergraduate retention issues. I focus on these students' identities, using figured worlds (Holland et al, 1998) as the main theoretical lens through which to analyse my data. I do this from the perspective of identity and learning, and more specifically mathematics learning, so I also draw on other researchers' work in this area.

Something that many of these students referred to in relation to academic support was that the initial problem about feeling alone in not understanding the mathematics, started to ease when they could identify other students, and later members of staff, as

potentially “friendly”. I therefore also look at research on friendship, and relate it to this educational context by looking at how these students attempt to categorise both peers and staff in terms of the support they provide them.

In this chapter I will therefore be revisiting identity, but this time looking more specifically at this group of students in terms of their relationships with each other, and with staff, in the context of their studies and their department. The impact these relationships had on the students, in terms of the support they gained, or didn’t, and how this changes over the period of their degree, are also investigated.

Theoretical Framework

Identity revisited

In the previous chapter I started to look at theories on identity development. I referred to a comparison by Stryker and Burke (2000) between three relatively distinct usages of the term identity and discussed two of the three categories. Here I will explore further the use of the third categorisation of identity, which Stryker and Burke’s state is,

> “…with reference to parts of a self, composed of the meaning that persons attach to the multiple roles they typically play in highly differentiated contemporary societies.” p. 284

As also touched on in the previous chapter, Holland et al. (1998) write about identity being people’s self-understandings formed through experiences in particular cultural worlds and their social activity within those worlds. At this point in my analysis the concept of ‘trajectory’ therefore comes to the foreground and theories of identity are therefore useful. In this chapter I therefore chose to use the theoretical lens of figured worlds to help investigate the students’ experiences, looking this time specifically in terms of their relationships with their peers and staff, in the context of their studies, their department, and more specifically in terms of the academic support they did, or did not, encounter.

Therefore, and in some contrast to my thesis up until this point, my theoretical focus now shifts towards a view of identity as being dynamic, and constantly changing

over time. Adopting this shift in theoretical framework had a big effect on how I viewed the students' interview data, and adopting this socio-cultural approach I feel enabled me to capture some of the complexity of how these individuals moved through their degree, and their time spent in the socially and historically constructed world of this mathematics department. By changing my perspective on identity to one where it is a much more fluid and complex construction, negotiated by individuals as they move through, and within, figured worlds, it made me rethink how the students spoke about the way they viewed, described and categorised themselves. In particular I was interested to explore what the interviewees said about academic support gained from peers and staff by looking at identity as a moving positioning of self, and positioning by others.

Holland et al. explain the term figured world as,

> "By 'figured world', then, we mean a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others. Each is a simplified world populated by a set of agents (in the world of romance: attractive women, boyfriends, lovers, fiancés) who engage in a limited range of meaningful acts or changes of state (flirting with, falling in love with, dumping, having sex with) as moved by a specific set of forces (attractiveness, love, lust)." p.52

Figured worlds therefore take into account not only the interactions of the agent members within them, but the personal history and social experiences that each of those members brings to the figured world, described by Holland et al. as an individual's "history-in-person" (p.18). The theory of figured worlds is not an isolated concept, but is part of a larger theory of self and identity by Holland et al. It is intimately tied to identity work by focusing on identities forming in process or activity.

In figured worlds people ''figure'' who they are through the activities and in relation to the social types that populate these figured worlds and in social relationships with the people who perform these worlds. People can therefore develop new identities in figured worlds, but as also noted in the previous chapter, Holland et al. argue that this identity formation is an ongoing, ever-evolving process, and those people who are not sufficiently engaged by a particular figured world will not develop "much of 'an' identity" (p. 190) within it. Holland et al. suggest that there are four contexts

which are sites where identities are produced: figured worlds, negotiations of positionality, space of authoring, and world making, with figured worlds being the foundation for the other three contexts.

With regard to the other three contexts where identities are produced, I paraphrase below a section of Urrieta's 2007 work, "Figured Worlds and Education: An Introduction to the Special Issue" to help me concisely describe them all.

- "Positionality" refers to the positions that are "offered" to people in different figured worlds e.g. "loud student" or "smart student". According to Holland et al. (1998), positionality can be analytically separated from figuration because when people are positioned they are not engaged in self-making. They are limited to accepting, rejecting or negotiating the identities being offered to them, along with those narratives borne out of historical significance, and the distribution of power, rank, and prestige (or the lack thereof).

- "Space of Authoring" is credited by Holland et al. to the influence of Bakhtin and his concept of dialogism, which is the ability of people to make sense of themselves through multiple internal dialogues. People are forced to make choices, and respond (or not, since, as Derrida (1996) proposes, a non-response is also a type of response) to the positioning that occurs within a figured world. Holland et al. propose that dialogism leads us to conclude that figured worlds must be answered, and the form of these answers is not predetermined. Authorship is therefore not a choice.

- "World Making" is attributed by Holland et al. to derive from Vygotsky's studies of play and analyses of the historical emergence of several figured worlds. They propose that through, what they term, "serious play" (p. 272, 1998) on the margins of newly imagined communities, entirely new figured worlds can become concretised through the creation of "new ways, artifacts, discourses, acts, perhaps even more liberatory worlds" . World making therefore brings us full circle back to the original context of figured worlds.

I found these four contexts in which identities are produced useful to bear in mind when analysing my interview data, but especially postionality and space of authoring. As Urrieta goes on to say,

> "Figured worlds are therefore processes or traditions of apprehension that give people shape and form as their lives intersect with them. In figured worlds people learn to recognize each other as a particular sort of actor, sometimes with strong emotional attachments, value certain outcomes over others, and recognize and attach significance to some acts and not others. Whether people are drawn into or recruited into them, or by some other means enter particular figured worlds, depends on who they are and their personal social history (history-in-person)." p.108

Figured worlds are conceived as social realities where the focus is on activity and the importance of power, and where the effect power has upon relationships is emphasised. Although, Holland et al. state that figured worlds can be called ''as if'' realms, most are more substantial than fantasy. Figured worlds are encountered by individuals in their day to day social activity and lived through practices, and identities are thus formed by their participation.

Although Holland et al's theoretical framework of figured worlds underpins this chapter, it is not the only work I have drawn on. I also looked at recent research on identity specific to an educational context, both to draw on ideas that relate to my study, and to see what is missing from the literature that my research could contribute to.

Identity and learning

The move away from purely psychological theories of identity towards a sociological approach has become more and more prevalent during the last three decades. For those educational researchers that view learning as a social, as well as a cognitive, process, in other words something that consists of shared experiences within different communities, an individual's identity is not something that is fixed, but is constantly shifting and developing through participating in, many and varied, communities.

> "Students' learning in the mathematics education community (for example in school class) is characterised by an actualisation of their identity through their interactions with the teacher, the books, the peers they engage with.

> These interactions are determined by the social context they are situated in, but on the other hand, students bring with them the experiences of numerous other practices in other communities they have participated." Kaasila et al, (2005) p. 216

In the context of an educational setting a student's identity changes within a practice as they become more adept at that practice, or as other students around them become more adept, and their positioning changes. And as Esmonde (2009) states,

> "…just because they are constructed in the moment and are therefore not predictable does not mean that individuals have perfect freedom to construct their identities or subject positions in any way they choose. Collective practices, including group work within a mathematics classroom, make subject positions available to students" p. 1012

As Solomon (1998) also argues learning in a mathematics classroom is not just about the acquisition of mathematical knowledge but about learning appropriate behaviour and language, and how to interpret the context of the lesson, and as Black (2004) adds,

> "learning how to be perceived as a high ability pupil." p. 357

which some students find easier to negotiate than others. Black et al (2010) also state that,

> "Key to the learners' relationship with mathematics is their evolving sense of self and their understanding of how mathematics fits with this." p. 56

All of which clearly relates to Holland et al's contexts of positionality and space of authoring, in terms of how pupils, or students, are positioned by both staff and peers, how they chose to accept, reject or negotiate these positions, and how the space of authoring offered to them effects how they make sense of themselves.

In looking at what the students in this study said about their relationships with their student peers, lecturers and tutors, in terms of the academic support and how they differed from individual to individual, I felt it was important to try to look at their academic identity separately from their social identity, whilst acknowledging how intertwined these are. As Reay et al. (2009) state in their study of working class students in elite universities,

> "It is important, therefore, to separate out learner from social identities, and to understand the varying extent to which individuals are able to move in and out of different identity positionings." p. 1115

What I also felt was an important aspect to my study, that had not been a feature of much previous research in this area that focuses on the first year experience, was to see how these relationships differed throughout their degree course. As Palmer et al (2009) reported,

> "…there is a wide range of turning points associated with the students' betwixt transition, which shapes, alters or indeed accentuates the ways in which they make meaningful connections with university life. Moreover, transitional turning point experiences reveal a cast of characters and symbolic objects; capture contrasting motivations and evolving relationships; display multiple trajectories of interpersonal tensions and conflicts; highlight discontinuities as well as continuities; and together, simultaneously liberate and constrain the students' transition into university life." p. 52

Here Palmer et al's definition of "turning point experiences" appear to me akin to those of "critical incidents" which Tripp (1993) describes as,

> "… are not "things" which exist independently of an observer and are waiting discovery ... but like all data, critical incidents are created. Incidents happen, but critical incidents are produced by the way we look at a situation: a critical incident is an interpretation of the significance of an event." p. 8

> "the vast majority of critical incidents . . . are not all dramatic or obvious: they are mostly straightforward accounts of very commonplace events that occur in routine professional practice which are critical in the rather different sense that they are indicative of underlying trends, motives and structures." p. 24- 25

Critical incidents are therefore not necessarily major events involving a lot of drama or tension. They could be small common place events that occur in the everyday life, of say a lecture room but their criticality is based on the justification, significance, and meaning given to them, both by the individual involved, and those around them. As discussed in Chapter 6, Palmer et al (2009) focused on the first term of the students' time at university,

> "Because the decision to leave is generally made within the first six to eight weeks (Odell 1996)". p. 43

and they were looking at issues of retention. By looking at a longer time frame, I saw that these "turning point experiences", or "critical incidents", occurred throughout the three years of the student's degree course.

Also, for the students interviewed in this study, their mathematical identities (a construct put forward by Bikner-Ahsbahs (2003), that not only describes the relationship the students have with the mathematics, but the interactions with their lecturers, and peers, that affect this relationship) are by definition determined by the context within which they work throughout the whole of their degree. As will be seen, some of the students spoke about how their mathematical identity changed during their three years, and the only way we can gain a better understanding of these changes is to follow the students over the course of their university career.

As already discussed, the concept of figured worlds is a distinct move away from previous static notions of culture and one which highlights the fluidity of identity. I therefore felt it to be a useful theoretical lens with which to view this educational setting. I wanted to somehow bring these students experiences to life, and show the complexity and movement throughout their three years at university in terms of their interactions with staff and peers. Holland et al.'s concepts of positionality and space of authoring in particular enabled me to look at the academic support across this timeframe and draw out different aspects to compare with previous researchers work on students' attitudes.

"Friendships" in an educational context

One other aspect of the data that I felt demanded attention was the students' references to friendships that they had, or hadn't formed. As my study progressed and various analytical accounts unfolded I became more and more data led. This at times prompted me to expand my literature search in directions that ultimately were too extensive to pursue. In this section I therefore present a brief synopsis of some of the literature on friendship, with the caveat that it does not always sit comfortably alongside figured world theory, but that I wanted to acknowledge the importance the interviewees placed on the term "friendship", although, as will be seen, it proves to be a difficult concept to define.

As argued in the previous chapter, the forming and sustaining of social relationships was very important to the students in this study, and could not therefore be over looked. The nature of many of the relationships these students formed early on with their departmental peers became academic as well as social, and vice versa, with these two aspects often being intertwined. In their interviews the students spoke less about their friendships with their tutors and lecturers, and more commonly they referred to how "helpful or unhelpful" they felt these members of staff were.

Previous studies have already shown that both peer-group relations, and staff-student relations, can play an important role in success of those studying mathematics at university. For example, the UK-based Student Experiences of University Mathematics (SEUM) project (see Brown and Macrae, 2003) found that the student - tutor community (or lack of) had an impact on how students experienced their university study, and that those students who worked together, or lived with other successful students, were more likely to be successful themselves. Solomon et al.'s (2010) study of mathematics support centres at two UK universities suggests,

> "…that a central issue in adjustment to university mathematics is the nature of relationships with tutors and peers…" p. 422

The SEUM project also found that the students' perceptions of their tutors were dependent on perceived aspects of their personality akin to the "friendliness" that the students I interviewed sought e.g. approachability, enthusiasm, and willingness to interact. The SEUM students also spoke about a tutor's ability to make difficult material interesting and accessible.

As Wilcox et al (2005) also note,

> "In this transitional phase students have an urgent need to belong, to identify with others, to find a safe place and to negotiate their new identities as university students, and friendship is about having friendly faces around and making initial contacts which may or may not develop into friendships." p. 713

In researching the term "friendship", I found little research in this area specifically pertaining to undergraduates' perceptions of friendship. One phenomenological study by Crissman-Ishler & Schreiber (2002) in the USA looked at first-year female students' perceptions of their pre-college and new collegiate friendships during their

first-year experience. They mainly concluded that the students studied had trouble letting go of old friends and investing in new friendships.

Another study by Parker & De Vries (1993) investigated both the structural and affective dimensions of undergraduates' relationships with their closest friends. Here the structural aspects were: age, sex, duration of friendship and frequency of contact, while the affective aspects were: self-disclosure, appreciation, assistance, empathic understanding, deepening others' self-awareness, shared activity, authenticity, trust, control, responsibility, connectedness, empowerment of others and satisfaction. Results from this study indicated some similarity between men and women in terms of the ranking of these dimensions by importance,

> "Women and men do not differ in the importance they attach to eight of the seventeen variables, including: sex of friend, duration of friendship, frequency of contact, assistance, trust, responsibility, empowerment and satisfaction. Trust and authenticity are the two most highly rated values for both men and women; age and sex of friend are similarly rated the lowest. Men attribute significantly greater importance than do women to age of friend, shared activity and control. Women attach significantly greater importance than do men to self-disclosure, appreciation of other, empathic understanding, deepening the other's self-awareness, authenticity and connectedness." p. 622-623

However, two broad patterns of difference emerged on the affective dimensions, in that "relationships with men friends were less reciprocal than relationships with women friends" and "men's same-sex relationships were characterized by less giving and receiving".

When looking more broadly at research on friendship, I discovered it to be a very difficult thing to define. As Adams et al (2000) state,

> "It has become a cliché to begin articles on friendship with a discussion of how its definition varies across individuals, as friendship is voluntary and not subject to as many institutional constraints as are family and neighbor relationships. Most researchers who study various aspects of friendship structure and process use one of three approaches to dealing with this definitional variation. They either ignore the complexity, bemoan it because when they compare people's friendships they are inappropriately comparing different entities, or eliminate it by instructing the people they interview to use a limited definition in discussing specific relationships." p. 117-118

I confess to adopting the first approach, by largely ignoring the complexity, in that a

definition of friendship is not my primary area of research interest. Much research has been done in terms of the importance of friendships, at all ages, but it can mean different things to different people, and even the same people at different stages of their lives. I won't therefore try to provide a distinction here, other than to say that these students were very aware that they weren't trying to find "soulmates", initially at least, just peers and staff who they felt comfortable discussing their work with.

I am therefore acknowledging that the students in my study no doubt had differing definitions of friendship, but that various aspects of categorisation by the interviewees did become apparent in my data analysis, as will be seen later in this chapter. Having said this, repeatedly in the students' interviews was something underlying, especially when they were struggling early on with their academic work, in that they wanted to identify people who, to them, appeared "friendly", as already discussed in the previous chapter. How these students pick up on the signals from each other, and from staff, and distinguish whether they are "friendly" is also not something I'll address here in any depth, as I do not have enough data.

In addition to 'friendliness' or 'approachability', a second aspect to their search for academic support was that of finding "equals". As Hartup (1992) writes,

> "The essentials of friendship are reciprocity and commitment between individuals who see themselves more or less as equals. Interaction between friends rests on a more equal power base than the interaction between children and adults."

And even more specifically,

> "Above all, friendships are egalitarian. They are symmetrically or horizontally structured, in contrast to adult-child relationships, which are asymmetrically or vertically structured. Friends are similar to each other in developmental status, engaging each other mostly in play and socializing." p. 1

Hartup's article on relationships as educational contexts is with respect to school children, rather than undergraduates, but much of what he writes about is relevant to this study. Childhood relationships with peers can have a substantial bearing on an individual's social and cognitive development later in life, and for many of the students in my study starting at university followed directly from being at school. I'm

not trying to argue that friends are an absolute necessity, since, should friends not be available, other relationships may adapt to encompass the functions that friendships serve, but, as Hartup (1992) puts it,

> "Children with friends are better off than children without friends, but if necessary, other relationships may be substituted for friendships. Consequently, friendships are best viewed as developmental advantages rather than developmental necessities, and the current evidence concerning friendships as educational contexts should be read in this light." p. 3

The functions of friendships I referred to above are categorised by Hartup (1992) as:

> "Friendships are:
> - emotional resources, both for having fun and adapting to stress;
> - cognitive resources for problem-solving and knowledge acquisition;
> - contexts in which basic social skills (for example, social communication, cooperation, and group entry skills) are acquired or elaborated; and forerunners of subsequent relationships." p. 1

Again, although Hartup writes these functions of friendship in the context of school children within educational settings, they can equally apply also to the context of students at university, particularly in terms of emotional and cognitive resources. In terms of the third function of contexts in which basic social skills are acquired, I would argue that for many students starting at university these skills are still being developed, and so continue to be an important function. This is especially important for those who have transferred straight from secondary schools with their own sixth form, as for these students it could be the first time in many years that they've been in the position of needing to form new friendships.

Findings from the students' interviews

As discussed in the previous chapter the first term of the first year was particularly hard for the students I interviewed in terms of developing social support, both within their department and their hall of residence. The shift in focus for this chapter is towards the student's academic identity, and so the primary context becomes that of mathematics department in which these students were enrolled. As Hartup (1992) suggests, looking at friendships within an educational context, they can provide both an emotional resource, for having fun, and adapting to stress, as already seen in the previous chapter, as well as a cognitive resource for problem solving, and knowledge

acquisition. It will be seen that these two aspects of friendship weave together in different ways for different students, as well as at different times during the three years of their degree.

What I aim to highlight in the data analysis that follows is how individual students categorise others and, how through this gradual process of differentiation, their own identities are shaped, and change over time. This occurs through their acceptance, rejection or negotiation of the positions that are offered to them by other students and by their lecturers and tutors, but is also determined by the boundaries of their own authoring space.

Table 7.1 shows which of the students contributed to each of the following sections of my data analysis. I have included all ten students interviewed in this table for completeness, but once again note that not all the students contributed to each section. As I did previously in Chapter 6, I now provide the reader with further explanation as to why this is so. Although in the case of Adam I reiterate here that much of his interview data was lost due to technical issues with the recording equipment, and similarly for Jane, who was so softly spoken that sections of her interviews were inaudible.

Name	**Overlap between social and academic support**	**Academic support, identity and achievement**	**Egalitarian approach to finding academic support**	**Spatial context of the Dept and the effects on students in terms of academic support**	**Academic Support from Staff**
James		√	√		√
Lyn				√	√
Hakim	√		√		√
Rafik	√		√		√
Sarah	√			√	
Yen	√				
Steve	√				
Jane					
Charlotte	√	√	√		√
Adam					

Table 7.1: Interviewed students' contributions to the sections in this chapter

Firstly note that the second section of my analysis deliberately focuses on two students only, James and Charlotte. This was to investigate what effect, if any, academic support had in terms of their identity, in light of their starkly contrasting exam results.

The other sections in this chapter emerged from a constant reviewing of all of the interviewees' quotes relating directly and indirectly to academic support. In some cases students reiterated what others had already said, and therefore quotes were not used if merely repetitive, and in others a general sense of a topic was gained from the majority of those interviewed but specific quotes was chosen to highlight key issues.

The initial overlap between social and academic support

Many of those interviewees who had spoken about the anxiety they felt early on in their degree course in terms of getting to know other students socially, also voiced more specific worries when it came to talking about interacting with their departmental peers. In addition to all the identity work forced upon them in terms of working out which groups they belonged to socially, they also spoke about their concerns about working out which group or groups they belonged to academically. As already mentioned in the previous chapter these two aspects of identity do overlap, and in the early stages of their course this was often difficult to separate out in my analysis. This is also apparent when investigating their attitudes, as reported by the SEUM project (Wiliam, 2005),

> "Our analyses highlighted the difficulties of separating out students' attitudes to their academic work from their attitudes to, for example, their social and emotional lives: all impacted on and influenced each other." p. 3

As discussed in Chapter 6, feelings of loneliness started to dissipate quicker for those who early on found peers in their hall of residence, and their department, to talk to, and in some cases tentative friendships did start to be formed in these first few weeks. These initial conversations with other mathematics students therefore provided the students with the beginnings of both social and academic support. For example, in those first few weeks struggling with the coursework forced some students to make initial contact with others that they might otherwise have been slower to make.

> It took me a while to sort of introduce myself to people. I didn't think they'd be interested, to be honest, but, I mean, when everyone's sort of doing the same problem sheet and you're all stuck, you just sort of make friends, and you're all sort of asking each other for help. [Rafik]

In fact all of the students interviewed expressed a desire to discuss their work with others during their time at university, through establishing at least some level of interaction with their peers. In the same way that we saw in the previous chapter that these students formed initial categorisations of others around them, both in their halls of residence and in their department in terms of them looking for social support, they also did so when searching for academic support. For many this process started when they were seeking out those peers they felt were approachable, "friendly faces" in the crowd who they could make some sort of connection with, even if they weren't going to form lasting friendships, and developed through working together on coursework problem sheets, or discussing topics being covered in lectures.

Charlotte, like Rafik, found that difficulties with the coursework early on forced her to initiate contact with other students in this way. In retrospect she felt this was a good thing, and that she had ended up being really well supported by some of her peers during her first year. She therefore spoke positively about the support she found from other students during that period and felt that it had been initiated due to the challenges that the coursework had set her.

> I think coursework sort of brings you together because if you can't do it, you want to, like, ask everyone else, see if they can do it. And you just make friends because you have to work together. I think that helps. Also, it helps you understand the work, because if they don't set coursework, you don't look at it and then, when it comes to revise, you just don't know what any of it's about. I think it's good that they set coursework. [Charlotte]

Hakim also appreciated talking to other students about the coursework problems, although not because he found them difficult, as Rafik and Charlotte clearly did, but because he saw the benefit of gaining others peoples' perspectives on the problems set.

> Yeah, I think, as far as homework goes, I probably, I talk to other people, because then you can actually check it and it goes quicker, you know, people have different ideas and you can quickly get through the rest of your homework, then. And most of them are relatively easy to do by myself, but I think it's better

> to actually do it with other people, you talk to them and you get a better understanding, because everyone has a different view on things. [Hakim]

These initial interactions sometimes flourished into long term friendships and sometimes didn't. The students were all just trying to establish themselves in this new figured world and "figure" who they were through the new relationships and activities, such as the necessity of completing coursework, being forced upon them.
I noticed quite early on that for some students this process appeared to be made easier because they were within a subgroup of the large cohort, in that they were studying for particular joint honours degrees with only a small number of other students. Within those I interviewed, Rafik, Steve, Yen and Sarah were all studying mathematics and physics (from an initial group of 10 students who started their first year with this as their degree pathway). As I discussed in the previous chapter, they established their friendship to some extent through their constant proximity, and being within such a small, close-knit group that took all the same courses for the first two years, meant that they formed a bond that helped them to overcome the initial feelings of isolation quicker, and possibly more easily than some of the other students interviewed.

Rafik and Steve were both living at home, but Yen and Sarah were in halls of residence, and although they all mentioned the same difficulties very early in their course of being in large lecture theatres and the lack of opportunity to interact with their peers, they spoke less overall about these problems than the other students interviewed, but also their focus on this topic dissipated quicker in each subsequent interview, than with the other students. In fact I initially interviewed them as a group, which was about six weeks into the autumn term of their first year, indicating to me a feeling of comfort and camaraderie between them that none of the other interviewees seemed to have forged with a group of other students that early on in their course. They also decided to be interviewed as a group again in their second year.

For this group the emotional and cognitive support they provided for each other were clearly even more closely linked than for the other interviewees. The academic support they provided for each other was no doubt enhanced by their initial proximity of studying the same courses and being in the same tutor groups, and appeared to benefit them long term too. Unlike many of the other students who spoke

about positioning others within their department, and self authoring in terms of their desire to find a group to join, these students had a ready made group from the start.

Rafik was undoubtedly the most vocal, amongst the interviewees, about his need for support from others. From the very first one-to-one interview I had with him he spoke about his concerns and feelings on the matter. As already seen in Chapter 6, many of his comments showed how important he found support from people around him. He was the only one of the interviewees to speak extensively about family, peers, and staff as all being important to him at different times during the three years. Without the support of his parents following his struggle in the first year mid-sessional tests he might well have dropped out of the course, a turning point experience that had a positive effect on Rafik in terms of his studying. That's not to say that other students interviewed didn't each mention one or more of these groups in terms of the support they gained from them, but I felt Rafik stood out in the way he expressed his appreciation for this support. Certainly in terms of the academic support of his peers he appeared to be more conscious of how much he gained from it, in that he articulated it more than the other three students in this subgroup.

Although there is a lack of data, in terms of Steve, Yen and Sarah having relatively little to say about their fellow students in terms of academic support, they did all mention in passing that they worked with others within this small group (it was down to just seven students by the second year, from the ten that started the course initially) and I always had some sense of them sticking together as a group, whether being interviewed together, or all complaining in their individual interviews about the timetabling difficulties of their course being split between two departments, and them approaching one of their lecturers about it as a group. Yen and Sarah also shared a flat, along with three other girls from different departments, in their second year and told me that they would work on their coursework problems individually but then consult each other if they were stuck.

> We usually do it separately, and then if we can't do something... [Sarah]

Having this small group within the overall cohort also seemed to act almost as a safety net for Rafik, so that by the end of the second year and into the third year, as

we saw in the previous chapter, he was ready to branch out and meet new people through his volunteering, and his choice of third year module options. He was by then comfortable with his identity within this small group of his peers, and this enabled him to have the courage to seek friendship with others in his department and the university as a whole. In putting himself forward to be a student ambassador he was self-authoring as successful, both as student, but also more specifically as a mathematics student.

In this opening section of my analysis I have looked at the tentative start of these students' journey towards adapting to their new figured world within this department, and their year group cohort. For many it was through their initial search for contact with friendly faces, being forced together through the need to complete coursework, or the constant proximity of a small subgroup that led them to the beginnings of new friendships and academic support from fellow students. And during these early weeks the academic and social support were very much intertwined.

The trajectories of the students I interviewed all took very different paths during the three years of their degrees, and although Rafik, for example, went on to flourish in terms of his mathematical identity and sense of belonging, both within his department and the university the same could not be said of some of his peers. I move next to focus on two students who although had very different trajectories, and indeed final outcomes in terms of their degree results, ultimately did not look back on their experience of being in this department with the fondness and enthusiasm that Rafik did. I present these changes by focussing on the academic support they gained, or lacked, from others. However, their stories do highlight the ever-evolving changes in identity that all these students went through during their three year course.

Academic support, identity and achievement

As we saw above Charlotte appeared to feel well supported during her first year, however she found herself enjoying her studies less and less during the three years as she began to really struggle to keep on top of the coursework. Charlotte made friends within her department in her first year. However, as we can see from the quote in the previous section, as well as what we saw in Chapter 6 when she said,

> In my first year, right at the beginning, I made some quite good friends, but then a lot of them dropped out. [Charlotte]

Losing many of her friends in this way at the end of her first year had a huge impact on Charlotte and when she reflected on her course she pinpointed this as being a turning point in her enjoyment of her degree.

> I think probably in the second year. I hadn't got many friends, I couldn't do the work, there weren't that many people to ask anymore. So, I found that sometimes it was very difficult to get the work done, I couldn't do it myself. It was at that point where I started to think, it wasn't really what I wanted to do anymore. And from there it just went downhill. It's just, every time you get homework, you get it and you just can't do it. [Charlotte]

We can also see here that Charlotte, through no fault of her own, has been forced to respond to the positioning that has occurred, by her friends dropping out, by self authoring as someone who cannot do the work set. By her third year though she had chosen to find a group of other students to approach, at least in terms of any difficulties she had with the coursework. This appeared to be a form of coping mechanism for her, and to me highlighted how different her peer relationships in her third year were compared to those in her first year, as she clearly gained no social, or emotional, support from them.

> Now, I've got some … who aren't really friends, but it's just that they're useful, and you … they work with each other, and so on, not really what you'd call proper friends. [Charlotte]

The students Charlotte had formed friendships with in her first year had provided her with the social support she needed then as well as, to a certain extent, providing some academic support. As we saw in the previous chapter she spoke about students on other courses in her hall of residence she had bonded with socially too, as well as these students in the mathematics department who then dropped out, and she spoke positively about that period of her degree. However, by gravitating socially to students in her department on a similar, and lesser level academically to her, when many of them dropped out it highlighted her weaknesses too, in terms of how much she really struggled with the subject matter. In the second year it was much harder for her to form new friendships within her department, as most other students had already established their groups to some extent. The space of authoring available to

Charlotte in her second and third years were severely limited by how she had been positioned in her first year.

As Holland et al (1998) said "…identities are not static and coherent, but variable, multivocal and interactive". Charlotte is a case in point here. Although she was interviewed just once during her third year of study this gave her the opportunity to reflect on her time at university, and voice how much her mathematical identity (Bikner-Ahsbahs, 2003), changed during this period. She had gone from having a perception of herself as being a relatively successful student within a group of supportive peers in her first year, to one of a struggling student with little or no support, to one with essentially only intermittently "useful" acquaintances within her peer group during her third year. Charlotte's comment about "not really what you'd call proper friends" implies a type of categorisation that she has applied to her relationship with these peers. Describing them as "useful" also conjures an image of them as a tool or resource for her to make use of during her studies. However, she clearly isn't happy with this situation and felt very isolated. With her struggling academically, as well as socially, she no longer positively identified with the mathematics, a subject she had previously enjoyed and chosen to study for three years.

> Yeah, at A Level I really loved it but since I've been here, it's like they've taken something I love and crushed it and now I hate it and I never want to use it again. [Charlotte]

When asked how she had felt about the mathematics during the first few weeks of her first year, a period when many students who are struggling with the work chose to drop out or change course, she replied,

> I thought that it would be different, I just didn't realise it was going to be that different. If somebody had told me back then what it was going to be like, I would not be here to do maths. But, in the first year, I hadn't even realised that it was not what I wanted anymore. [Charlotte]

It could be that during her first year the difference she mentions between A level and university level mathematics, did not seem insurmountable as she had both social support from her peers, and academic support from both her peers, and one of her

tutors (which I'll discuss more in a section later in this chapter). However, once the friendship, and support of other academically weaker students had gone, she felt there was nothing left for her to enjoy during her time at university. This combined with the lack of staff support too as tutorials were only offered to first year students, she realised how much she was struggling with the work, and her perception of previously enjoying the subject waned. It could also be that the enjoyment she spoke about during her first year was more related to the fellowship she felt with the other students rather than the actual mathematics, and so the dramatic change in her mathematical identity (Bikner-Ahsbahs, 2003) was initiated by her loss of social and academic support in her second year, in that many of her friends dropped out entirely, or retook the first year exams. Her identity had changed therefore within the practice, not as a result of her becoming more or less adept with the mathematics necessarily, but due to the changes in cohort around her. And as Murphy (2008) states,

> "… individual agency is a situated, negotiated experience and identities emerge in the interaction between students' experiences and their social interpretations, over time." p. 162

Charlotte's limited space of authoring and resulting isolation from the rest of her cohort was also amplified in terms of her accommodation during her second and third years (she shared a flat with her father), and her socialising (she relied heavily on her pre-university boyfriend whom she spent most weekends with) and left her with no real sense of belonging at university. Having said all this Charlotte did complete and pass her degree with third class honours. She clearly had enough determination to finish her course, and chose to be successful in terms of passing her degree. This was despite her becoming increasingly disengaged from her studies and previous enjoyment of mathematics, as she was no longer enjoying her university experience and was merely going through the motions.

> After . . . I've done so much, I'm not going to quit now, . . . and that's why I'm still here, or I wouldn't be otherwise. [Charlotte]

While Charlotte found various friendly faces early on but then struggled to make new friends when many of her friendship group dropped out, James had a different problem in terms of developing relationships with his peers. As we saw in the previous chapter, he was someone who very early in the first term of the first year,

clearly thought he didn't fit in, as he felt much more "mature", both socially and academically, than most of his peers.

> But how do I fit into the department? Yeah, . . ., there's plenty of people I get on with, . . . sit next to anyone and talk to them. But in terms of friendships overall, I don't think so, there's nothing at all. The people I hung out with in the first weeks of term, obviously, I got rid of them, because they weren't very interesting. But, no, I just couldn't find anyone I particularly wanted to be friends with, it's so inane. But, I don't mind, I've always been a bit of a loner, but sometimes it's not wonderful, especially when people tell you how great things are. [James]

James' positioning of other students as not "interesting", and self authoring as a "loner", can be attributed in part to him being much less dependent on his peer group for academic support than say Charlotte. James could at times rely entirely on his own mathematical ability to cope with the academic work without much interaction with other students, or indeed staff. He didn't require support from others, in the way that Charlotte did, to maintain his academic identity, particularly in terms of his view on mathematics as a subject. During his second year he confessed to a period when he attended very few lectures, and yet his end of year exam results didn't particularly suffer.

> Lectures, I didn't go to any, just one or two in my first term, almost nothing, because I felt rubbish, and also the lectures were rubbish. [James]

When Charlotte was faced with having little support from peers or staff she grew increasingly frustrated with the mathematics, but James never encountered that as he coped with the work without the support of others. Like Charlotte however, he did have a desire to find other students to discuss the academic work with, and maybe because he didn't seem to find them, ended up positioning his peers in terms that implied a type of categorisation, or maybe even "ranking", in a similar way that Charlotte had.

> Most of them are associates rather than friends. But, sure, I have a few drinks with them and they'll phone me up and perhaps invite me to parties or whatever. I don't know, I don't feel I developed any close bonds with anyone. [James]

He also expressed a view that there was little or no sense of the mathematics department as a whole, as a "community", which no doubt stemmed from his feelings of isolation and not belonging.

> I don't think there's much of a feeling of camaraderie in the maths department, anyway. I mean, it tends to be – the vast majority of people couldn't give a monkey's about maths and a lot of people aren't very good at it. I mean, even people of a medium ability at maths, they can get better, a lot better, just by putting in a huge amount of work and caring about it, and I know a guy who has done that. Well, most people don't care, and lecturers don't care, and there's not much student-staff involvement. And, of course, it's very difficult to have that when you have such huge classes, so many people in a department. [James]

In fact, despite him often dismissing his lack of friendships as being any problem or anxiety for him, it was clearly something he did want, as was seen in the earlier quote when he notes,

> …but sometimes it's not wonderful, especially when people tell you how great things are. [James]

and again in his comparison of the mathematics department with that of the medical school.

> I don't know, there's not really any department ethos, or much of a department ethos, it's a very loosely knit community, if you can call it a community at all, the Maths department, it's nothing compared to, say the medics. [James]

In very different ways Charlotte and James' stories highlight some of the difficulties that students face in terms of identity formation during their time at university. As Holland et al. (1998) argue that this identity formation is an ongoing, ever-evolving process, and as we can see in Charlotte's case changes over the period of her degree had a dramatic effect on her identity. Holland et al. also refer to people not developing "much of 'an' identity" (p. 190) in particular figured worlds as they may not ever be "sufficiently engaged" by that world. This appears to be the case for James who did not particularly engage with his peers or develop any real sense of belonging within the department, or the university. Although Charlotte initially sustained her engagement through the interaction with other students and staff, once both these means of academic support had in effect been withdrawn she struggled to maintain her once positive mathematical identity.

Neither James nor Charlotte, in her second and third years, found the academic support they wanted from their peers, or indeed members of staff. However, in possible contrast to previous research, for these two students their lack of a sense of belonging by the end of their degree was not necessarily an indicator of academic failure. James achieved a first class honours degree but did not reflect positively on his time at university, nor felt he would keep in contact with his peers. Charlotte achieved a third class honours degree, but did so through sheer determination having had very little academic support from peers or staff during her second and third years, so arguably was still successful in passing her course. She also left university with an overall negative view on her experiences of studying in this department. In the context of this department then maybe "becoming" a successful student in terms of academic achievement in examinations did not always rely on "belonging" as such.

An egalitarian approach to finding academic support

The problem of finding other students to relate to in terms of academic support was clearly key to a lack of sense of belonging in James and Charlotte's cases. These two students are both outliers of the cohort in terms of academic ability, which seemed to make it difficult for them to find equivalent peers to discuss their work with. James positioned the other mathematics students as immature and below his academic level, whereas, once the friends she had made in the first year all dropped out, Charlotte positioned the students who continued into the second year with her as somehow academically better than her, although in reality it is more likely that other students of a similar ability were just not known to her, or also hid themselves away as she did.

As already seen in the previous chapter, and again in some of the interview quotes so far in this chapter, the students categorised their peers throughout their time at university in a bid to find others to bond with in some way. Hakim, for example, had a strong sense of the positioning of groups of students within the mathematics department, and during his second year reflected on some of the different groups he had categorised.

> There's kind of different subgroups, and you kind of know different people so you go out in different groups. Well, I still know the same people as . . . well, I've met some people but they're not really people you necessarily go out with, I just met them this year, so it would just be people I know just to talk to or whatever. Mainly, this year, I've met people actually are interested in maths. That's kind of a group - there's another group that really like going out, another group that there's people nice to hang around with, and there's just different groups. [Hakim]

As also touched on in the previous section, whether subconsciously or not some of the students in this study appeared to be looking for a symmetrical or horizontal structure in their friendships in terms of cognition, as described by Hartup (1992). Students working together on coursework problems, or at least checking their answers with each other, were gaining valuable academic support, but no doubt also using it as a way of comparing their abilities with others. At the start of the first year however they had no "yardstick" by which they could compare themselves with their peers academically. In terms of seeking out their "equals" within the cohort, they knew that they all achieved very high grades in their "A" levels, as this was the requisite to gain a place to study in this department of mathematics, one of the leading ones in the UK. However, many of them were so used to being positioned "top of the class" for mathematics that to suddenly be surrounded by a cohort who they perceived to all be as good as, or better than, them at mathematics, was initially unsettling in terms of the space of authoring it appeared to give them. Some of them resorted to identifying different students' mathematical abilities by where they would sit in the lecture theatres.

> In the Maths Department, you see little groups forming, and there's a group full of all the really, really smart people at the front, if you . . . stay at the back, yeah, you see the groups. And I tend to hang about with the people who sit at the back of the lecture. [Rafik]

Of course Rafik, while positioning this group as the "really, really smart people" he was also referring to them as a "outgroup" (Tajfel & Turner, 1979). He did not count himself as "smart", and therefore did not see this group as potentially one he could belong to. In terms of this figured world he was positioning these other students, and in doing so Rafik was also responding to the space of authoring this left him, and in doing so trying to make sense of himself.

James on the other hand, who spoke extensively about his disappointment in his fellow mathematics students' lack of interest, and would no doubt have self authored himself as "smart", also sat near the back in lectures to start with. He justified this decision in terms of him wanting more physical space around him.

> Well, I sat at the back most of last term, and sometimes I do, just simply because of the fact that as you get to the back it becomes more sparse. Some people have a problem washing. And, anyway, if you take a hundred and forty youths and stick them in a room, it's not going to be very pleasant. It's not very good for disease transmission, either. I have an incredibly powerful immune system and I've just got my second bad cold of the academic year, one bad cough. [James]

However, James may also have been sitting at the back initially to gain more of an overview of the cohort he was so disdainful of. Despite him positioning most of his fellow students as being both immature, as seen in the previous chapter, and not very good at mathematics, for example,

> There are quite a few really gormless people in the class, or at least you'd think, from some of the questions they ask, some of the answers they give. [James]

he did still express interest in finding his academic equals within the year group. In the same way that Rafik had positioned the group of students who sat at the front of lectures as being the "really smart people", James soon recognised this too, and later in the year, and I felt unusually for James, he did end up conforming to this stereotype that Rafik had spoken about. He made the conscious decision to sit with this "really smart" group, and in doing so was choosing to respond to the positioning of this group, by himself and others, by self authoring. However, he still remained somewhat disdainful of their mathematical abilities.

> This term, I have started to associate in Maths generally with a bunch of people who sit on the front row of my class, who are actually a bit better at Maths than most of the other people in there. Because I've started paying more attention in my lectures, because if you're listening then, then that reduces anything else you'll have to do when you're outside your lectures, the time is valuable. I was going to say time is money, but it's not . . ., it's valuable in its own self. [James]

The comparison of their abilities, and egalitarian approach to finding support, from others, is not necessarily something that is specific to mathematics students but may

well be more prevalent than with students studying other subjects. Previous research has certainly shown that

> "University mathematics students continue to depend on positive test results for their identity confirmation (Rodd & Bartholomew, 2006; Solomon, 2007b)" Black et al (2009) p. 3

This focus on test results might point towards them being more likely to seek out their academic "equals" than students studying other subjects.

This dependence on positive test results could be due to so many mathematics undergraduates continuing to have strong beliefs about mathematics being a black and white subject area, in that they think problems only have one correct answer, and method of answering. They become averse to, even fearful of, the risk of "appearing stupid" in front of their peers, and their lecturers if even slightly unsure how to approach a problem. This anxiety and fear of failure in mathematics (Buxton, 1981) is even true of those students with high academic ability who still don't feel comfortable sharing their opinions on a problem in the same way that maybe a student of History, English or Law maybe would, these being subjects where it is perceived that more value is placed on the individual's interpretation of the problem, than any final correct or incorrect solution to the problem.

This combined with, for many, a lack of opportunity to discuss mathematics in formal settings, fuels the dominant view that mathematics is an individual pursuit, and has also long been exacerbated by the view of a typical mathematician, or mathematics undergraduate, being somehow "socially inept" or "geeky". As Mendick (2004) highlighted when researching student's choices of studying mathematics at 16+,

> "…most participants divided the population into maths people or non-maths people. The former were variously depicted as socially incompetent 'nerds' and as active problem- solvers." p. 44

However, recent research challenges the view that mathematics is an isolated, or indeed an isolating, activity. Boaler and Staples' (2008) research showed the value that school students found in discussing multiple methods and solutions, in mixed

ability groups, and work with undergraduates by Solomon et al (2010) also presented the students'

> "ethos in practice towards a recognition that everyone has different perspectives and understandings." p. 429

There were indeed more comments made by this group of interviewees about discussing their work with their peers, than there were about them working alone. As we saw earlier even Yen and Sarah who professed to working separately on their coursework, would come together if they came up against any difficulties. This informal support that the students provided each other, which happened naturally without any intervention or encouragement from the department, in fact produced mixed feelings amongst members of the academic staff. Interviews conducted in another research study[1] that looked at groupwork in mathematics education, showed that a spectrum of opinion on the matter ranged from feeling strongly that this type of informal working together on coursework problems should be actively discouraged, through to it being important that the students supported each other in any shape or form.

For example below are comments from two lecturers in this department who were interviewed about their opinions on groupwork in mathematics, and would appear to have opposing views.

> By and large, I think the whole idea of group co-operation in mathematics is a disaster. [Lecturer A]

> I know it is somewhat heretical but I think that copying down someone else's answers is better than nothing. It's a bit of contact with the material, you know. There is kind of a continuum with true co-operation at one extreme and mindless copying at the other, but in the middle it can be all very grey. [Lecturer B]

However, what even these two lecturers agreed on was that they thought it important in any collaboration of student's work, or indeed their own on joint research papers, that it was done amongst those of pretty much equal ability.

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[1] See MacBean et al (2001, 2004) for further details of this study, but please note that these interviews with staff were not the main focus of this research, and were therefore never written up in anything published.

> Now, in a sense, there doesn't seem to be anything wrong with collaboration, if all the parties to it are essentially equal and that everybody understands what's happening. [Lecturer B]

> Maths is the kind of subject which can be quite difficult to have a discussion about it and it can easily turn into one person doing it and the other person writing it down. And it maybe that really students on a similar level need to talk to each other, rather than having one better and one..... [Lecturer B]

So essentially the difference between these lecturers' views was that one believed that student peer support was a disaster because it rarely occurred between equals, and the other who believed that it worked better between those of equal ability, but that any level of peer support was better than none. Although, as already discussed earlier in this chapter, most of the students were initially looking for others they felt to be of equal ability in their department, not all of them managed to find such support. That's not to say that they didn't benefit from the peer support that they did find however. Hakim, for example, appreciated being able to discuss different ideas, even though he could usually manage to keep on top of his coursework without doing so. And for Charlotte, just having other students to check her coursework solutions with was quite possibly enough to have kept her from potentially giving up on her degree entirely.

The students interviewed for my study certainly started off their time at university looking for "others like them", but this continued, albeit to a lesser extent, throughout their three years. In the previous chapter we saw that they spoke about their peers in terms of categorising them socially, as ingroups and outgroups, but this section has shown that this also came through in how they spoke about them academically. For many of the interviewees this seemed most prevalent in the way that they expressed their desire to find other students who they perceived to be on a similar level to them academically, and the positioning that occurred in this process. This was particularly noticeable amongst those students who spoke about their disappointment in not managing to find others to discuss their work with, be that because they felt they were academically superior to most of the other students, or because the students they had originally found for academic support then dropped out, or failed their first year exams. Being in such a large cohort initially made this whole process difficult and sometimes positionings were based on factors such as

where students sat in the lecture theatre. In the next section I discuss some of the other problems having such a large year group brought.

The spatial context of this Mathematics Department and the effects on its students

The students in this study were enrolled in the Mathematics Department of an inner city, Russell Group, university, which is highly regarded as one of the best in the UK. Like many mathematics departments it suffered from a drop in student applications during the 1990's, but combated this by increasing the number and variety of joint and combined honours courses it offered. This led to a huge expansion over the last twenty years in terms of the number of undergraduates admitted to the department in each first year cohort. At the end of the 1980's approximately fifty undergraduate students were offered a place to study each year, but by the time the data was collected for this study, in the early 2000's, this number had almost tripled. Currently the department admits over two hundred first year students year on year.

This rapid expansion has brought with it problems in terms of physical space in that there is no lecture room within the mathematics department large enough to fit the whole first year cohort. All of the modules they studied during this period were compulsory, and some of them were core courses which all of the students took whether they were enrolled on a single, combined or joint honours course. This meant that the class size of this particular cohort was almost 150, so the first year lectures had to take place in large lecture theatres outside of the department, and made it even more difficult for the students to get to know each other.

> Well, the lecture theatres are so big that I didn't really – I mean, I talked to a few of my close mates but that was it. You go in, you sit down, there's a lecture, you leave, and everyone goes their separate ways. [Lyn]

Many of the interviewees in the first year felt that they could not ask questions of the lecturers in these large lecture classes, but also that they couldn't speak to their peers.

> To me I think tutorials are a good way to get to know people, because in a lecture there are so many people that I wouldn't talk to them. [Sarah]

> You can't really socialise in lectures, and a lot of people, they've all got their own groups, they form groups early on, and to be honest, I can't make much effort. [Lyn]

Lyn again here is referring to groups of students within this figured world, in a similar way that James, Rafik and Hakim did in their comments earlier in this chapter. This positioning of others is something she dismisses as requiring effort that she's not prepared to put in. Her refusal of this positioning is probably due to her confidence in her own identity. As discussed in the previous chapter she had taken a year out before starting her degree and had done some traveling. Like both James and Hakim, she expressed her disappointment at the lack of maturity of her peers at times, and her self-authoring, as someone with more life experience than them, was evident throughout her interviews.

However, things changed a lot in the students' second year. Firstly the cohort size had diminished considerably from the original list of 142, down to 99 students continuing into their second year. Also they had a choice, albeit limited, in what modules they could take and so the many of the class sizes became even smaller. Lyn for example felt she made more friends within her department during her second year.

> So, this year, people are more friendly and they're more willing to discuss problems and ask questions and it seems more comfortable, and it helps because we're in smaller rooms, there's not as many of us. And when you're in a room rather than a theatre, people ask more questions and it becomes a bit more fun and there's more interaction. [Lyn]

As we saw in the previous chapter, Lyn lived in a hall of residence in her first year and although she felt that many of the other students living there were very immature, the hall of residence was big enough that she met others she got along with, and she mostly socialised with them rather than those on her course. In her second year however she moved into a shared flat with a group of students she didn't already know, who were all studying different subjects, and who were often not in the flat at the same times of the day as her. This forced her to put more effort into forming friendships within her department but the smaller class sizes by then helped her to do so.

> I've been socialising with my class more. So, in our breaks, I'll meet up with some guys from mechanics or one of the lectures, and we'll sit and do the problems together. So, in that way, I talk to a lot more people from maths. [Lyn]

Although the expansion of this department in terms of the choice of combined and joint honours degrees that are on offer, and the sheer number of students given places year on year, is a positive thing for a subject area that has seen departments in other universities close entirely, the effect on those students of being in such a large cohort should not be underestimated. Most of these students had been used to smaller than average class sizes in mathematics during their A level studies, due to choosing a subject area less popular than many others, and the contrast of then sitting in a lecture theatre with 150 other students is therefore made even more stark. Coming to terms with this in terms of their self authoring, and the positioning of others, can be viewed at times as being in conflict, and at others as being helpful, for them to fulfil their desire to find academic support from their peers and from staff.

Academic Support from Staff

So far this chapter has focussed primarily on what the interviewees said about their interactions with other students in terms of academic support, so I turn now to the academic support offered to them from their lecturers and tutors. Aside from lectures in their first year, the students also were expected to attend problem classes and small group tutorials. While it's maybe not surprising to find that most of the students would not ask questions in the large lecture classes it did become apparent that this anxiety was not just because of the number of people present. Some of the students would not ask questions in tutorials either which, as discussed in the previous section, could partly be due to the fear of failure in mathematics (Buxton, 1981) and not wanting to appear "stupid" in front of their peers, especially not during the first few weeks and months of their first year.

> I didn't feel there was anyone I could talk to about my problems in the course, and stuff. I know I had tutoring and stuff, but when you're sitting in the tutorials, you see everyone understanding the work and you think, well, if I put up my hand and say I don't understand, they might – you know, so that's the only reason, basically. But, this term, I'm understanding the work a lot more, so I don't find the need to put my hand up and say I don't understand. [Rafik]

Rafik's anxiety in tutorials, about admitting he didn't understand the work, was partly due to him positioning the other students in terms of their ability. During the first term of the first year he thought that he was the only one who was struggling with the work, but as we saw earlier in this chapter and again in the quotes that follow, as he started to discuss it with his peers, outside of tutorials, he realised that others were struggling too. This in fact would have had a two fold effect on Rafik in that not only did the academic support from peers help him to understand the mathematics more, hence him not often feeling the need to "put his hand up" to ask questions in tutorials, but also would have alleviated the anxiety that he was the only person in a tutorial not understanding.

> It's nice to know that you're not the only one struggling on your problem sheet. And when I got to know more people, I thought that I wasn't the only one, that really we were all together, we were all in this together and we're all experiencing the same difficulties. And the friendships enabled me to – like, I mean, if I had a problem, I could go to my friend and, likewise, they could come to me. And you just feel more sort of – you feel more part of the university experience. [Rafik]

This support from his peers also seemed to lead to him developing better working relationships with his tutors too.

> It was difficult at first, but I made quite a few friends and I've got a good relationship with my tutors now. So, I feel that if I did have a problem I could go to them quite easily now and talk to them whereas, in the first term, I didn't think I could. [Rafik]

As already discussed Rafik had gained a lot of support from his parents during his first term, and they helped him during the turning point experience of his mid-sessional tests at the beginning of the second term of the first year, when he seriously considered giving up on the course entirely. Following this turning point the social and academic support from his peers began to build, and the momentum he gained seemed to take him from strength to strength. He was able to accept and engage with this new figured world he had entered, and as he gained in confidence with his work, he was in turn able to approach members of staff for help more readily.

> In terms of the lecturers, in the second year, I kind of – I don't know, maybe this is the way they were teaching, but I felt more sort of connected to the lecturers

> and I felt confident in going to them after the lectures and actually talking to them. [Rafik]

It was a shame in some ways that tutorials did not continue into the second year, as it clearly took students such as Rafik a while feel comfortable enough to appreciate their worth.

> Yeah, in the first term, I thought tutorials were just a waste of time. Maybe it was because our tutor used to make us actually do a question on the board, and I used to hate that. But, then, as time went on, after mid-sessional exams, I started to pay more attention, and I realised they were really helpful. You'd go over questions and, I mean, our tutor's really nice because he'd sort of do a question similar to our problem sheets, not totally the same but once you do the question at the tutorials you have an idea of how to do it. So, yeah, I really started paying attention, I really enjoyed the tutorials, in fact, I miss them quite a lot, actually. [Rafik]

Rafik again here refers to the anxiety he felt when asked to answer questions on the board, as already discussed earlier in this chapter, and this clearly clouded his judgement initially as to the usefulness of these tutorials. In fact for others, like Charlotte, tutorials were a lifeline that she needed, and would have probably appreciated even more on entering her second year, as most of her peer group had dropped out, or were repeating their first year courses so she had little or no peer support. She, in particular, spoke about one tutor who she found to be really helpful during her first year.

> My applied tutor was really good, he was for the mechanics side of it. In the beginning there was no, . . . we just couldn't get on with it. So, we went to see him every week. The tutorial stuff was only supposed to be an hour, but he put two back to back, so we always tended to stay for a full two hours. He was just really, really helpful, means you actually understood it, which was quite nice. Even after the first year when we moved on to the …, and he didn't know it as well. I … I could see it, I mean, he was still quite useful. [Charlotte]

> I mean, I've asked him for a reference, because I think, out of everyone, he knows me best. [Charlotte]

Charlotte did however differentiate between the relationships she had with her tutors. Having spoken so enthusiastically about her applied tutor in terms of how helpful he was, she mentioned her other first year tutor.

> Yeah, one of my tutors was really good, my personal tutor was really shabby, and I've not been to see him since the beginning. And it's supposed to be every how ever often it is. [Charlotte]

When asked to explain a bit more what she meant when she described him as "shabby" she continued,

> He seemed a bit wishy-washy and confused. Unhelpful and quite shy. And there was one time, because his tutorials weren't very relaxed, and there was one time I was the only one there, and that was the last time I went, because I didn't really know him … very well, he was, like, "I don't want to help you too much." And so we basically sort of sat there, nobody was saying anything to anybody, and it was just very uncomfortable. So, I didn't go back after that. But the other one was really, really good. [Charlotte]

Charlotte clearly did not find this particular tutor's approach helpful to her. She appreciated the more nurturing and flexible approach of her applied tutor and although she didn't say that this "shy" tutor was unfriendly, she clearly felt uncomfortable enough to decide that she wouldn't attend his tutorials again, implying no help was better than his attempt at helping.

Hakim stood apart from the other students I interviewed in that his enthusiasm for a specific area of maths led him to do additional studying, outside of his lectures and coursework. One of the lecturers had offered to provide him with additional reading, and some one-to-one tutoring.

> And in terms of the staff, some people, I wouldn't say they're my friends, but they are quite friendly . . . There's one guy who's actually taking time out to teach me something, not giving . . . the courses. So, he recommends I read a book, every week I read a chapter and go and see him, Tuesdays it happens, and then spend, you know, two hours going over it with him. . . . the fact that he's actually – you know, he's a researcher, he's got stuff to do, he's got work to do, but he actually takes the time out, I'm not taking an exam . . . it's purely for my own interest, and he's actually doing this. I mean, that is quite rare, I don't think there's many other people in the department who do that, but . . . just some really, really nice people in the department. If you're willing to learn they are willing to help. I think most . . . people, they are really friendly. [Hakim]

In his second year though Hakim mentioned briefly in passing, that he didn't feel he had a particularly good relationship with one of his first year tutors. He started by saying he was "pretty good" but that they "…didn't seem to get on personally".

> He was professional and friendly, but we don't really share similar interests. He wasn't as willing to talk about things that weren't directly related to the course. I wasn't . . . the course, he wasn't . . . And so, yeah, he was friendly but . . . and I was the only one doing any work, towards the end I was the only one turning up, everyone else, once they realised it wasn't compulsory to turn up, they didn't bother, . . . He wanted to cut it down as quickly as possible, half an hour. [Hakim]

However, when he brought the subject up again in his third year interview he reflected at length on various incidents where this tutor had made him feel uncomfortable and, on one occasion, he even felt had humiliated him. It struck me how much the relationship with this particular lecturer had affected Hakim, and how he had obviously spent a lot of time worrying about it.

> I don't know why, my tutors are a bit weird and they don't talk to me much. I see some people with their personal tutors . . . chatting . . . I don't know what it is, but one guy, he's really professional, so when I go and see him, I have a mid-term talk with . . . so he's all professional about it, and asking how things are, but if I see him in the lift or something and I say, hi, he'll barely acknowledge me. And a few weeks ago, we were both in the lift and we were going down, he was playing with his mobile 'phone or whatever, and he was looking at me, in a very strange way, I don't know, it was kind of weird. And I remember when I was the only one turning up to his tutorials, . . . he like tried to get rid of me after half an hour or whatever. If I've annoyed him, I don't know, maybe I just ask too many questions or irritated him. [Hakim]

> He's one of these guys, if it's not related to the course, he's not going actually doing it, he doesn't really want to know. I remember that, he always said you have to learn all the calculations . . . . . I'd be using things – I don't know, he gave me advice, I wasn't ignoring his advice, but I don't want to be critical, . . . The other people there, I was better than them, and he, like, maybe because they weren't as good, he encouraged them, but with me, it was like, I don't know, it was strange. [Hakim]

This strained relationship with his tutor, who was also his personal tutor, in retrospect had affected Hakim's confidence in his first year. He went on to tell me about the incident he felt to be quite a public humiliation, that occurred in a lecture where he answered a question this particular lecturer asked of the class, but the lecturer dismissed his answer by saying "*Oh, yeah, but you've done that in a tutorial, with me*", which he hadn't. Hakim clearly took it very personally, still dwelling on it two years later, although having not spoken to me about it at the time.

> I didn't mention that at the time because I was not sure, but over the time I reflect on it and I realise it was maybe…, especially in the second term, I realised that somebody liked me. [Hakim]

His comment about realising that someone liked him was in reference to the tutor who he saw weekly for the additional "reading course", as he described it. Hakim, as already seen, was someone who, like James, felt he was more "mature", both socially and academically, than many of his peers. He clearly sought affirmation from members of staff of this, and wanted them to view him as someone with potential to be one of their "equals".

This is why I think he had been so concerned about what his personal tutor thought of him. He felt he had been positioned as someone who could only have answered the question posed because it had already been discussed in one of their tutorials. Being "put down" by him in public like this, and not given the credit he felt he deserved, was something that clearly annoyed Hakim, and made him question his identity. Forced to make a choice in response to this positioning may well have spurred Hakim on to seek out a member of staff who would take him seriously.

Interestingly the two students who voiced negative interactions with one of their tutors, i.e. Charlotte and Hakim, also both praised another tutor. In Charlotte's case she was lucky enough to have found a lot of support from her other first year tutor, and in Hakim's case it was the lecturer who, in his second year, supported him by seeing him weekly with the reading course.

However, of the other students interviewed, most barely mentioned tutorials, other than in passing. James for example early in his first year commented,

> … not too keen on my pure tutor, quite abrasive. [James]

but he didn't elaborate, and the conversation at the time quickly moved on to another topic. Considering tutorials are the main formal support provided by the department for their first year students, I would have expected them to voice their opinions more, and the lack of data in itself, is important.

The other students interviewed spoke in more generic terms about "lecturers", not pinpointing particular individuals. Mostly their comments were how much easier it became to approach lecturers for help in their second and third years. For example, Rafik, in his third year, reflected on how his relationships with the lecturers had changed over time,

> They were quite funny, as well, I remember, we had one lecturer who was really quite funny. It was just a more enjoyable experience, the lectures were more enjoyable because of the lecturers and, because you were, like, more relaxed and you're more enjoying it, you understand the work a lot more. And, again, because I'd built relationships with the lecturers, I could go to them afterwards and say, "Right, I don't understand this," and they could explain it to me. So it was good. [Rafik]

Lyn also felt that relations with the lecturers were more relaxed in the second year,

> Now we're in classes and you joke about things with the lecturer, and it's much nicer. So, I reckon, by next year, I'll be like pretty friendly with most of the people in the maths group. [Lyn]

Students' relationships with their lecturers and tutors, in terms of academic support, clearly took much longer to establish than those with their peers. The interviewees spoke little about members of staff during their first year despite tutorials only taking place then. Many of them only really discussed their interactions with tutors in hindsight during their third year interviews, however this was possibly due to them not feeling comfortable talking about their tutors with me at the time. In terms of the lecturers who taught them, the students only seemed to properly start interacting with them in their second and third years. This could be due partly to the smaller class sizes, as already discussed, which made it easier to ask questions, but also partly for some because they were by then feeling more confident with their own academic identity as a mathematics student, having established themselves within a supportive peer group.

Discussion

In this chapter the focus of my analysis of the students interviews has been on academic support in terms of their interactions with both peers and members of academic staff. Holland et al's figured worlds has provide a useful theoretical

framework to help me to investigate what these students said about their relationships, and gain a better understanding of the processes they go through. This came through in terms of how they positioned others, and what space of authoring was left available to them, and subsequently how academically supported, or not, they felt at different times during their degree.

What this chapter has again highlighted, by building on the work in Chapter 6, is the considerable amount of identity work forced upon these students during their three years of studying. Working out which groups they belonged to socially was their primary concern initially on arriving at university, but within the first year, and into their second and third years, the interviewees spoke about the worries of working out which group or groups they belonged to academically too. As already noted in previous chapters these two aspects of the students' identities do overlap, but I have tried to address them separately to gain a better understanding of how the students move between different identity positionings (Reay et al, 2009) but acknowledge where I feel the main overlaps occur.

Upon entering the new figured world of their university department, the interviewed students spent time positioning other individuals and groups of students within the cohort, in a similar way that those who lived in a hall of residence initially did. As we saw in the previous chapter the students wanted to interact with their peers early on in their degree to gain social support, whether or not they were having any difficulties with the academic work by then, and this occurred primarily during the initial separation stage of their rites of passage. Whether subconsciously or not, many went about this by trying to identify friendly "others like them" that they believed to be approachable.

The difference was that within the departmental context, the students actually had mathematics as an obvious common ground with these peers, and for some the overlap between their desire for academic and social support was difficult for me to separate in my analysis. Although initially looking for friendly faces they also sought other students who would take them seriously, and give them time to engage in discussing their academic work. For many these initial interactions with their departmental peers did therefore stem from their desire to discuss their work with

others, and often more specifically their coursework problems, as they were trying to overcome the problem of feeling alone in not understanding the mathematics.

This could also be viewed in terms of Alderfer's regression theory (1972) in that the students' experiencing difficulties with the step up in the level of the mathematics in their academic work, i.e. cognition (a growth need) were redoubling their efforts with the lower order relatedness need of belongingness. The students' desire to discuss their work was therefore also partly for affirmation of their mathematical ability.

As the students moved into the transition stage of the rites of passage they continued to spend time positioning other individuals and groups of students within the whole cohort, looking essentially for their equals in terms of academic ability. Some of the students who took longer to find and make friends were those that tended to view their fellow mathematics students as immature, both socially and academically, and therefore did not bother to discuss their work with them as they felt they would not gain much in the way of academic support from them.

While clearly not the only criterion for whether others were deemed to be potential friends, similar academic ability played an interesting part. Although it was apparent that friendliness was initially more important to them than their peers "expertise" in the subject, their desire to find and forge new friendships did nevertheless have a distinct egalitarian aspect to it. Indeed a view also expressed by two members of staff in the department was that they both felt that academic support between peers worked best when the students were at a similar academic level. However research at school level (e.g. Boaler, Wiliam & Brown, 2000) has shown inherent problems in setting pupils in mathematics classes, such as those students in the lower sets never seeing the higher standards of others, and this can pose the danger that students like Charlotte are at risk.

Similarly, and in line with findings from the SEUM study, the students also put emphasis on the friendliness, and approachability of members of academic staff in terms of how much academic support they could gain from them. Most of the interviewees also appeared to establish themselves with some peer support, before

they sought out members of the academic staff for help, indicating a hierarchy in terms of who they perceived to be easier to approach for academic support.

A recent study by Hernandez-Martinez et al (2011) reports on students' positive perspectives of the transition from school to college following their GCSE examinations, and describe how they view it not as an obstacle to be overcome, but a positive opportunity to develop a new identity. As the researchers conclude,

> "It seems, then, that the learner-perspective on transition is somewhat different from that expected - the transition is an opportunity, and given the right connected support, students relish it." p128

The cohort in my study had similarly been looking forward to their time at university but for many their expectations were not met, even amongst those who completed their three year course and gained a good degree result. Often this appeared to be due to them lacking academic support from departmental peers and staff, and resulted in them developing negative attitudes.

It was noted at the end of Chapter 6 that some of the interviewees did not appear to reach the incorporation stage of the rites of passage, and these included the outliers, at either end of the academic ability spectrum, that found it difficult to establish or maintain a supportive academic peer group. These outliers in my study also fit with the descriptions of two groups of students identified by the SEUM study (Wiliam, 2005). Firstly the "hangers in" who struggled to cope with the work, became disillusioned with their lack of success in mathematics since A level and merely continued with their course to maintain self esteem and gain a degree qualification. And secondly those students who SEUM described as the "pragmatists" who were very or moderately successful in their examinations, had no real regrets in retrospect that they had studied mathematics at degree level but that held no passion for the subject by the end of their course.

I turn next to the part played by the context of this department in terms of helping or hindering the students to gain the academic support they were looking for. One of the dominating factors was the large class size for lectures, especially in the students' first year, which many of those students interviewed felt hindered them in terms of bonding with others, and therefore finding support. As already mentioned most

students were used to small class sizes at A level so coming to terms with the considerable amount of identity work in terms of the positioning of others, and self-authoring, forced upon them by the sheer numbers of students in their year group was difficult for them. This was made even more apparent when contrasted with the experiences of the small group of students studying mathematics and physics, since they appeared to bond more quickly as a group than the other students interviewed.

The department also provided students with both problem classes, which were less formal than lectures thus allowing students to interact with each other and members of staff, and small group tutorials. These students spoke very little about either of these two forms of teaching method, and when they did it was primarily about individual staff members. This lack of data is in itself quite telling.

The two students who spoke at length about individual members of the academic staff did so initially to praise those whom they felt had been particularly supportive and helpful to them. Both however countered this praise with condemnation of others, in one case to the extent of giving up entirely on tutorials with one particular tutor. The supportive student–staff relationships were certainly much more rare than the ones students had with their peers, but evidently made more of an impact on those students who were lucky enough to find them.

Also small group tutorials only took place officially in the first year in this department. There was one student who had found a member of staff willing to see him once a week for a “reading” course, outside of the usual material covered in modules, but for the majority of students small group, or one-to-one, support from members of staff was pretty much lacking in their second year. By their third year this became less of a problem as the course modules options opened up and therefore the class size in each module was much smaller. Additionally many of the students felt much more comfortable approaching their lecturers for help by then.

Conclusions

What this chapter has gone some way to establishing, is a better sense of how these students’ academic identities changed over the period of their degree. The theoretical

framework of figured worlds combined with the theories on friendships in educational contexts have contributed to my understanding of the data by highlighting how these students categorise their peers and staff through the processes of positioning and authoring, in terms of how they use them for academic support. The data presented has shown how students' identities change over the course of their studies and are influenced by their friendships and the academic support structures that they have in place, in similar ways to how they were influenced by social support in the previous chapter.

Returning to the students' rites of passage, data presented in this chapter has helped to further illuminate how some of the students in this study negotiated the transition stage by not only seeking friendly faces amongst their cohort, but by seeking their academic equals for support with their work. It also highlighted the difficulty that some outliers had in establishing, or maintaining, such academic support, and how this led to them never properly developing a sense of belonging and moving from the transition stage to the incorporation stage. These students' attitudes towards their department and mathematics as a subject appeared less positive at the end of their degree than at the start, and also less positive than those students who did find and sustain an academically supportive peer group.

Although my overall sense was that, in line with the SEUM study finding, amongst the students I interviewed there was a decline in positive attitudes to mathematics over the period of their degree course, my data suggests a difference in regard to the relative importance of factors that influenced the attitudes of these students. For the group of students I interviewed I felt that academic support, or lack of, had more of an impact on their attitudes to mathematics at the end of their degree than their academic success, but this could just be due to my having a smaller case-study group containing predominately successful students.

Chapter 8: Conclusions

Introduction

This concluding chapter reflects upon my study by looking at five aspects of the research. Firstly I return to the research findings to draw together my main conclusions from the study, and show how they relate to each other and my research question. I then consider the elements of originality contained in my thesis and discuss what contribution they make to the research field. Next I review my research approach by looking at both its strengths and its limitations, and include my reflections on the research methods I used by looking at how robust my research instruments proved to be. This leads me into the final two sections that discuss what implications for practice there are for my findings, and what further research could be undertaken.

Review of research findings

In this section I discuss the three main themes that come through in the findings of this study by returning to those discussed in my data chapters to see how they fit together, and how they contribute to the overall aim of this study to find out how these students' experiences and attitudes change during their degree course. I remind the reader here that throughout the study I adopted the tridimensional definition of attitude put forward by Triandis (1971), Hart (1989), Eagly & Chaiken (1993), Ajzen (1998), which encompasses emotional, cognitive and behavioural aspects, and that I kept this in mind while investigating the experiences of this particular group of students.

I also reiterate that the social and academic aspects of these students' experiences were often difficult to separate, so within these three themes I'll be discussing that there is some cross over between the findings of the data analysis chapters. Both the social and academic aspects were clearly important to the students throughout their degree but in different ways, and therefore both needed to be investigated in order to build up a full picture of these students' trajectories. Through my initial aborted attempts at analysing the interview data, as discussed in Chapter 2, I discovered a

contradiction between what the students chose on reflection in their third year as being of most influence on them during their first year, and what the interview data at the time showed. On reflection the students chose mainly academic factors as being important to them during their first year, and yet at the time the social side of university life had dominated their interviews. I would argue that this inconsistency also highlights both why a longitudinal approach is important, and that the social and academic aspects of students' experiences need to be understood both separately, as well as how they interact, in order to build up a full picture of the students' trajectories and sense of belonging.

Also in respect to my study being an investigation of approaches, support and identity, it must be noted here that identity, although used in Chapters 6 and 7 as a theoretical lens through which to view my data, does not feature significantly in my research findings.

Approaches to learning and conceptions of mathematics

The first main theme to address from my findings is that of the students' approaches to learning mathematics and their conceptions of mathematics, as some of my results differed from those in prior research. Although I found similar correlations between approaches to learning mathematics and conceptions of mathematics to those in earlier studies, contrary to expectations I discovered:

i. **no evidence that these students' approaches to studying mathematics changed over the period of their degree,**
ii. **no evidence that these students' conceptions of mathematics changed over the period of their degree,**
iii. **no correlation between the students' attainment in examinations and their conceptions of mathematics, nor between their examination results and their approaches to learning mathematics.**

Previous studies have reported as desirable that students take more of a meaning, and less of a reproducing approach to their studies (e.g. Biggs, 1987, Entwistle & Ramsden, 1983). In terms of the students' approaches to learning mathematics it might therefore be hoped that a shift would occurr towards the cohort adopting more meaning, and less reproducing approaches by the end of their degree, than they did at

the start, but no evidence of this was found. However, approaches to learning have also been shown to relate to the context in which they are situated (Laurillard, 1979), in terms of the teaching and assessment methods used.

Turning to the students' interview data it became apparent that many of them saw memorisation as key in terms of doing well in their examinations, particularly those in Analysis as a subject area. The same could not be said for the coursework questions set, which were described as being very challenging for even the highest achieving students, and this mismatch between examination and coursework problems proved to be frustrating for those students who expressed a liking for Analysis as a subject area. This was apparent across the spectrum in terms of the students' actual ability, ranging from those who attained a first class degree, to those who were struggling to complete their degree at all. These students expressed a disappointment that, despite their appreciation of this subject area and desire to understand it i.e. them taking a meaning approach to their learning, when it came to the exam they just needed to memorise theorems and regurgitate them, i.e. they could get through by taking a predominantly reproducing approach.

Even those students interviewed who did not particularly like Analysis as a subject area were disappointed in the amount of rote learning needed to answer the examination questions. Again this spanned the ability range, in terms of the students' examination results, but this time was expressed by those students who scored higher on the reproducing scale of approaches to learning.

What is interesting here is that despite these students acknowledging these "rules" of the assessment, it had no effect on their approaches to learning mathematics during the period of their degree course. Those students who started the course with more meaning approaches, acknowledged that you could get through some examinations by rote learning, but did not then change their belief in a more meaning approach overall, at least in terms of how they completed Questionnaire D. However, they would adopt a reproducing approach if they felt that was all that was required in an examination. Those students who started the course with more reproducing approaches had no real reason to adopt more meaning approaches to their learning, at

least in some courses, and yet some did still acknowledge that this was not how they wanted to be assessed.

Petocz et al (2007) found, when investigating cohorts in different years of their degree course, that those groups in the later years of study had a higher proportion of students with broader conceptions of mathematics than those cohorts in their first year of study. Although not a direct comparison of the same students over time, this study does lend weight to the possibility that there would be a difference between students' conceptions when they first started their degree, and when they complete it. With conceptions of mathematics being hierarchical (e.g. Crawford et al, 1994), a move towards their conceptions becoming more cohesive, using Crawford et al's (1994, 1998a, 1998b) terminology, or broader, using Petocz et al's (2007, 2010) as they learnt more about mathematics as a field of study might have been the expected. This would have meant that their conceptions of mathematics would have become more akin to those held by professional mathematicians, but again no such change was found amongst the 28 students in my study that completed the CMQ twice. I can only conclude that the teaching and learning context of this department had little or no effect on the conceptions of mathematics already held by these students on entering university.

This lack of change in these students' conceptions of mathematics is difficult to explain more fully though, as little relevant data was found in the students' interviews. However, taking prior research into account (e.g. Dreyfus, 1991, Perrenet and Taconis, 2009) it is reasonable to again suggest that this department may need to address certain issues in terms of its teaching and assessment methods. A detailed examination of the teaching and assessment methods within this department was beyond the scope of this study, but could provide insights into why the students' conceptions of mathematics did not change. For example a lack of explicit connections between different modules within the course, and how they build on each other would reinforce fragmented conceptions of mathematics, as would a focus on abstract concepts with little reference to their application. As already noted though, one thing that clearly needs to be resolved is the mismatch between the coursework and the examination problems set in Analysis. The coursework problems require students to have a good understanding of the underlying concepts, but then

the examination problems mainly testing their memorisation of theorems. I will therefore return to the lack of change in the students' approaches to learning and conceptions of mathematics later in this chapter when considering the implications for practice of my results.

Turning now to the last main finding under this theme which is that unlike previous research (e.g. Crawford et al, 1998a, and Reid et al, 2005) no correlations were found between approaches to learning mathematics, or conceptions of mathematics, and examination results. This result may seem surprising but was consistent with findings from the case studies. When comparing two students who took a more meaning approach to learning mathematics, and had more cohesive conceptions of mathematics, they achieved very different examination results. Similarly for the two students who took a more reproducing approach to mathematics and have more fragmented conceptions of mathematics, these scales did not relate to the students' final degree results, with one achieving a first class honours degree and the other a third.

Returning now to think about these students' attitudes towards mathematics I would propose that both their conceptions of mathematics, and their success in mathematics in terms of attainment, could be viewed as cognitive aspects of their attitude. With neither of these changing over time, or indeed being related to each other, I turn to the emotional and behavioural aspects of attitude to investigate further why some of these students' attitudes to mathematics did change over the period of their degree.

Student trajectories

The second major theme in my findings centred on the students' trajectories and their development of a sense of belonging. I do this by examining the processes described by Van Gennep's rites of passage, i.e. separation, transition and incorporation and comparing the experiences of the students I interviewed to them. The main findings I focus on here are that,

i. **students' rites of passage can occur over the whole period of their degree course,**
ii. **for some students the incorporation phase does not occur,**

When comparing my data to that in much of the literature on retention and attrition I found that many of the issues found to be important in students' decisions to drop out of university during their first term of their first year, continued to be important to those that completed their degree for the rest of their time at university. I would therefore argue that the rites of passage occur over a long period for many students, and certainly longer than Palmer et al's (2009) investigation of turning points within the transition stage occurring during the first 6-8 weeks of students being at university. While for those students who chose to leave this period may be crucial, for those that do not, their period of transition, or be-twixt state, can continue well into their second year, and beyond.

The first few weeks and months separation, in whatever form it occurred, was the primary cause of the students' desire for social support and relatedness to others. In trying to make these social connections, they were forced to confront, and even reconstruct, their own identity. What came through strongly from the interviews with these students was that relationships were important to them throughout their time at university, and key to helping them to develop a sense of belonging.

During the transition phase these students sought out friendly faces to provide them with both social and academic support. They initially spent time positioning other students and identifying "outgroups", then most found other students to at least talk to, usually in their hall of residence first and then their department. In agreement with other recent research (Wilcox et al, 2005, and McQueen, 2009) pre-existing social networks of family and friends also helped some students adjust to their new environment during this separation phase, and this was especially important to those still living at home.

This transition phase was when most students' sense of belonging started to develop. As their initial relationships developed too, they became friends with peers in halls of residence and their department, got to know members of staff better, and some students became more involved in their department and the wider institution through volunteering schemes. Those students who were most likely to lack a sense of belonging were found to be those that didn't find the social and academic support

they desired during this transition phase, and in one case found it during their first year, but then lost it again at a later stage of their course.

I would also argue therefore that some of these students completed their degree without ever experiencing the incorporation stage. They merely fell into a "holding pattern" of the transitional stage while waiting to complete their degree and move on to something else, as they did not want to waste the time and energy they have invested in their studies so far by giving up on their degree course. This is contrary to Tinto (1987, 1993) who proposed that unless a student successfully negotiates all three stages of Van Gennep's rites of passage they would fail to become integrated to the institution, and inevitably drop out of university.

For the students in this study that did not appear to have developed a sense of belonging to their department, or to the university, by the end of their degree, the lack of interest in, or connection to their subject was also evident. These students had not found enough social and academic support to feel connected to their department or their subject through relationships with other students or staff. However, this was clearly not necessarily an indicator of academic failure. Of the students interviewed there were those who did not identify themselves positively as "mathematics students" and yet achieved first class honours degrees at the end of their three years of studying.

Van Gennep and Tinto proposed that students' rites of passage follow the linear pattern represented in Figure 8.1.

Figure 8.1: Pattern of Van Gennep's rites of passage as proposed by Tinto for all completing students

As already discussed there were students interviewed for this study that never experienced the incorporation stage and merely became suspended in the transition phase, as represented by Figure 8.2 on the next page.

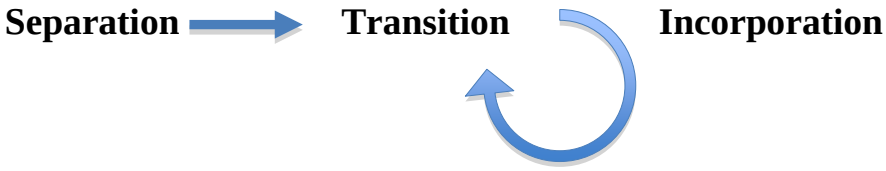

Figure 8.2: Pattern of Van Gennep's rites of passage as experienced by some completing students

One student even returned to the separation stage when the social and academic support she had found during her first year disappeared due to the peers she had befriended dropping out of the course, and the tutorials within the department stopping at the end of the first year, as represented in Figure 8.3. It is possible that other pathways through the rites of passage are experienced, but without further research this is purely supposition.

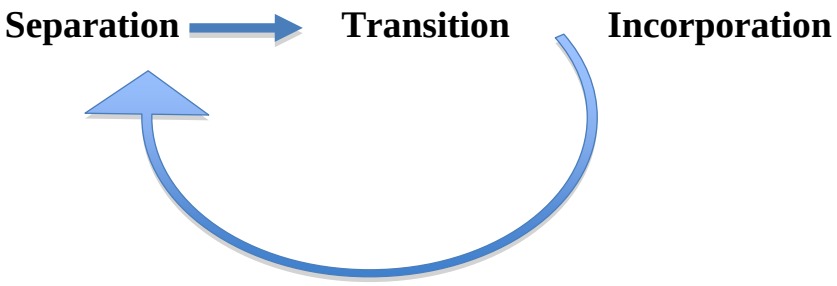

Figure 8.3: Pattern of Van Gennep's rites of passage as experienced by one completing student in this study

If the incorporation stage is all about students "becoming" a successful mathematics undergraduate by identifying themselves in terms of their sense of "belonging" in their department and the university, then there are clearly ways for students to pass their degree course without ever having completed the rites of passage. I would argue that however successful they are in their examinations, by not experiencing the incorporation stage and developing a sense of belonging, these students are more likely to finish their degree with negative attitudes towards their time at university, their department, and ultimately to how they feel about mathematics. However, I also acknowledge that I interviewed only a small sample of students on which to base this argument.

Students who develop a good support structure for themselves, and choose to become further involved in their department, or the wider university, through voluntary schemes, can then be seen as moving further into the incorporation stage of the rites of passage. In terms of the emotional aspect of their attitudes, their sense of belonging is fuelled by their relationships with others, and I would argue that the behavioural aspects are represented by the choices they make to become involved, or not, with voluntary schemes within their department, or representing their institution to the outside world.

Academic support

My final theme reports on the importance of mathematics undergraduates finding the right academic support, and therefore follows on closely from the section above. The main issue that came through was that,

i. **students are more likely to retain overall positive attitudes by the end of their degree if they establish and maintain sources of academic support throughout.**

The SEUM project found that academic success was one of the main influences on students' attitudes, but that it was not always an indicator of positive attitude to mathematics, which appeared to decline over time for all but a few students. I found that academic support, or lack of, was also an influence on the students in my study. In particular those students who did not find the academic support they desired developed little or no sense of belonging, and this impacted on their attitudes as argued in the previous section.

Taking the findings from both the SEUM study and my own, links between academic success, social and academic support, and students' attitudes towards mathematics are apparent, but still not clear cut. Although most of the literature on social integration and academic integration is in reference to student retention and attrition there is also recent research that claims these two forms of student integration positively influence study attainment (Eggens, 2007). Again, it is difficult to say whether my data supports or counters this claim. Of the eight main interviewees who I met with throughout their three years course, all of them achieved either first class

honours or an upper second, but I would say integrated to varying degrees both socially, and academically. However, not only was mine a small sample, but I have even less data for those students across the rest of the achievement range.

What I would argue is that finding an ongoing support group, whether of a similar academic level or not, helped some of the interviewees to maintain more positive attitudes to mathematics, but that finding this support was difficult for certain outliers. These included students who were highly successful academically but were naturally loners, whether because they were confident and didn't feel that that their peers were as mature as them, socially or academically, or shy and just didn't develop many friendships during the three years. At the other end of this spectrum were also those students who really struggled academically but had nowhere to turn for support, either because their friends dropped out, or because they couldn't help each other because they were all struggling with the work. For these outliers, the lack of academic, and to some extent social, support did impact negatively on their attitudes.

For some of the interviewees this was reflected in their less than positive attitudes to mathematics as a subject by the end of their course, but for others the negativity was expressed more in relation to their experience of being at university and studying in this department, than mathematics directly. By the end of the study I also had a sense that the eight main interviewees, and two students who I interviewed just once in their third year, appeared generally representative of the whole cohort in terms of their attitudes, if not the full range of academic ability in terms of attainment.

Originality

In this section I highlight the main elements of originality present in my thesis, which can be found in aspects of my research approach, the new use of a research instrument, the integration of literature from different bodies of research, and results of my analysis. I give just an outline of them here as each of these aspects is dealt with in greater detail in other sections of this chapter.

Research Approach

Aside from the SEUM project, no other research study has followed a group of British mathematics students through their whole undergraduate degree course, as far as I'm aware. By taking a longitudinal look at this cohort, linking both large and small scale research methods to investigate students' progress and attainment, as well as their views over the period of their course, I feel I have adopted a holistic approach. This is unlike most other empirical studies on students' experiences and attitudes that, for various reasons of constraint, are unable to take such an approach.

Research Instrument

The original aspects of this study are also included in my use of an established research instrument in a new way. Although, as discussed in Chapter 2, approaches to learning and conceptions of learning have dominated much of the research on student learning in higher education in the last three decades, I believe I am the first researcher to look for changes over time with the same cohort. I did this by administering the ASMQ and CMC to the group of undergraduates twice, once near the beginning, and again near the end of their degree course and then comparing the students' approaches to learning, the students' conceptions of mathematics each time.

Integrating Literature

Building on retention and attrition research by looking at these students sense of belonging over the three years of the students' degree, rather than focussing just on their first year as most of the literature in this field does, has helped to build up a better picture of the experiences of some successful mathematics graduates during their whole degree course.

Not only did I draw on work from different bodies of literature on student learning, attrition, and belonging, I also integrated various bodies of theory from wider than just the education field to help me interpret, and contribute to the empirical knowledge on students' experiences. It was never my specific intention to add to the theoretical knowledge of any of the different frameworks I have drawn on, but by using them to better understand these students' experiences I found examples of student trajectories that did not fit the linear pattern of Van Gennep's rites of passage, nor Tinto's supposition that all three stages are necessary for student retention.

Research Findings

In addition to the main findings discussed above, and the various results from my analysis of the data already presented in Chapters 4, 6 and 7, there were also other findings that, although already mentioned in passing early in Chapter 2, deserve further acknowledgement here.

Firstly during my preparation for the fifth round of interviews (conducted during the autumn term of Year 3) I identified 19 main salient factors that were of influence on these students during their first and second years. These factors were drawn together from the open coding of the students' interview data from Years 1 and 2. The resulting 19 categories were printed out on card and used with the students in their fifth round of interviews, during Year 3, as a way of asking them to rank three factors that had most influenced them during particular time frames of their degree course. These categories have already been listed in Chapter 2 and while my initial attempt at grouping them under the themes of social/personal, academic, home and work did not prove to be useful, the categories themselves were a useful finding.

In conclusion, my thesis has contributed empirically to the field of research on undergraduates' experiences, has explored a new way of using an established research instrument, has built on existing theory to expose new pathways through students rites of passage, and combined literature in a way that helped better explain the some of these students' trajectories.

Review of research approach

The pragmatic research approach I adopted in his study, and my use of mixed research methods throughout, have helped me to build up both an overview of this cohort of mathematics students by investigating trends within the group, as well as a more detailed picture of both the university context as they experienced it, and some of the relationships within it. As already argued in the previous section I feel that in taking this approach I have been able to undertake a holistic investigation into these undergraduates' experiences, and develop a better understanding of what influences their attitudes over the period of their degree course.

However, as with any empirical research study of this type mine suffers the usual weaknesses, discussed in Chapter 2, inherent when using questionnaires and interviews as data collection methods. This is in terms of my biases when developing questions, the students' biases in answering them, and again mine when later analysing the data.

The limitations of my study are also apparent in how generalisable my findings are. By investigating just one year group, in one university department, many of these findings are context specific. I only interviewed a relatively small number of students, and had a disappointing return rate for Questionnaire D, both of which also impact on whether some of my findings would be applicable to other groups of mathematics undergraduates, or departments. Also, by not interviewing a broad enough group of students, especially amongst those at the lower end of attainment in examinations, there were times when I was forced to shift the focus of the study due to lack of data.

What I have also become aware of is how this thesis can be viewed in terms of the conceptual changes and development of my research approach over the last decade, represented by my shift from a view of students' experiences, focussed on their approaches to learning, and conceptions of, mathematics, to a much more socially located and context driven one. Had I been able to anticipate this development, I would have designed the data collection differently.

Implications for practice

By looking at each of the three main themes from my findings in turn, I hope to highlight some of the practical implications of my study, in terms of those specific to this mathematics department, and also more generally.

Approaches to learning and conceptions of mathematics

The first area to address is in terms of how to encourage the students in this department to move towards adopting more meaning approaches to their learning over the period of their degree. One of the things I feel is key to this is to change the focus in certain examinations away from the regurgitation of memorised theorems. It is important for students to be able to recall and reproduce proofs, but as was seen

from the interviewees' reactions some of the examinations had too much emphasis on memorisation, especially when compared to the types of problems they had been set for coursework. Tackling this mismatch by reducing the amount of reproduction needed in examinations, but increasing it in either coursework, or "spot" tests in problem classes or lectures, could help to emphasise that students need to be able to reproduce theorems, but more importantly understand the proofs. This emphasis on understanding should be made much more explicit

A few of the students also expressed the view that the coursework problems were often much more difficult than those in the end of year examinations. Again, more of a balance is needed, as particularly difficult coursework can be very demoralising for those who are struggling, and even the high ability students found some so frustrating as to be then "disappointed" with the relative ease of the examination problems set. To help address the fact that within any cohort there will be a mixture of abilities, despite the high entry requires for this department, on each coursework the problems could be given a "grading" by the lecturer setting them in terms of their difficulty. For example the first few problems could be relatively simple, leading the student through particular new concepts and using a degree of repetition. Then a group of more difficult problems that challenge the students understanding of the topic, and finally a couple of examination level questions, primarily targeting those students who wish to be stretched in their thinking from early in the module. It must also be made explicit that not all students are expected to be able to complete these final two questions at the beginning of the module, but they will be a timely reminder nearing the end of the lecturing period what level of question they should be able to tackle in order to be comfortable going into their examinations.

More generally, research has shown that students tend to benefit from being encouraged to think about their own learning (e.g. Norton, 1995, Campione et al, 1989, Claxton, 1999). On a small scale for example, an exercise where students were asked to complete the approaches to learning mathematics questionnaire and then discuss their results within a group, may help them to appreciate how others learn, and whether the different approaches are important in different contexts. The SEUM study however also reported on the benefits to those students who enrolled on the "mathematics education" module available at one of the universities where their

research took place. A similar module has subsequently been offered to students studying in the department in this study, but began after this cohort of students had left.

In terms of broadening students' conceptions of mathematics during the period of their degree, there are several aspects of both the teaching methods and the content of courses that could be tackled. Firstly the lecturers need to acknowledge the range of conceptions that the incoming students will have of mathematics, and that many of them will be far from ideal in terms of the lecturers' expectations.

Highlighting the differences between school and university mathematics, especially during the first few weeks, is one area that could be addressed. This can be approached both in terms of the conceptions of mathematics held by themselves as mathematicians, as well as through the use of 'catalytic problems', which as already described in Chapter 1, are pivotal problems that aim to catalyse the progression towards undergraduate mathematics. Helping the incoming students to appreciate the similarities and differences between the mathematics they have encountered to date, and that of their new curricula, can be achieved through focussing on connections between different viewpoints, uses and representations of mathematical ideas.

Throughout the degree course, lecturers should also be more explicit within their teaching about how areas of mathematics fit together by relating content from different modules, rather than presenting their courses as discrete pockets of information. They should also try to make students more aware of the processes necessary to develop a greater understanding of their subject, not to focus on finding the "correct answer" but encourage their students to develop approaches to solving problems. This is particularly needed from the beginning in analysis, which is a field of mathematics that is new to most new undergraduates. Petocz et al (2007) have also suggested that showing students how mathematics is used by mathematicians in "real life" work, for example in industry in terms of application of theory, and how problems are tackled in academia by getting students to take part in a mini-conference, can help to broaden their conceptions.

Student trajectories

The next finding to address in terms of the practical implications is how to foster students' sense of belonging and encourage their journey towards the incorporation stage of their rites of passage. As class size was something many of the students mentioned hindered them in their first year from getting to know their peers, and knowing that the department has in fact grown in size since this study started, I would suggest using groupwork. It would be needed from an early stage of the degree course before students form their own allegiances, but might be one way to help students to move from transition to incorporation by encouraging small group cohesiveness, in a similar way to that which the joint honours students in this study spoke of. The groups should be formed at the beginning of the year, have a maximum of eight students in each, and be entirely separate from the tutorial groups, but since all the students in each group should be taking the same degree course path, this might not always be possible. The sort of tasks these groups should be encouraged to do could include some of those already mentioned above, i.e. completing the ALMQ and CMQ and comparing results, through to working together on the examination standard problems on the coursework.

Other possibilities to help the students to develop their sense of belonging within the department include different social activities within the department. These could be organised by second and third year students, but at the request of lecturers who could target those older students known to be active in different aspects of student life i.e. socialising in the student union, taking part in particular sports or the maths society. Such established students are typically more likely to participate in such activities if asked directly to take responsibility, and could be encouraged to use social media to help initiate both face to face get togethers, and an online community. The use of social media is also something that both the department as a whole, in terms of an online presence across all year groups, as well as individual members of staff in terms of their particular courses, could consider using to develop more of a sense of community.

Finally, more improved contact between the students and their lecturers should be encouraged from early in the first year in the department, again with the aim of forging relationships quicker. Staff and student socials could be arranged, and

although this is probably the most difficult to coordinate in terms of sheer numbers involved, this issue could be addressed through grouping students in terms of the degree pathways they have chosen. These groups will be taking mostly the same modules until at least half way through their second year, so helping them to bond and also get to know their lecturers more quickly.

Academic support

Finally, I turn to the implications for practice in terms of providing opportunities for more targeted academic support amongst, and for undergraduate students. Hernandez-Martinez et al (2011) in a recent study that reports on students' positive perspectives of the transition from school to college, where they view it not as an obstacle to be overcome, but an opportunity to develop a new identity, challenged the idea of transitional practices that make 'college more like school'. I would reiterate this in terms of students moving from school, or sixth form college, into university. What many of the students in my study had always enjoyed about mathematics was the challenge of problem solving, and even those who had struggled with the work on the course still held this as important to them. They were therefore not asking to be spoon fed, or have their hands held through their degree course, but I feel that they would have appreciated academic support from both peers and staff to be more easily accessed, actively encouraged, and at times more specifically targeted.

This department might therefore want to consider making some small changes in terms of the support they provide their students. Firstly the tutorial system needs to be made more supportive by tutors taking more responsibility, or administrative procedures put in place, to ensure that those students who stop attending tutorials don't slip through the net. They should be questioned about their experiences, and if appropriate given the option of changing tutors. Equally those tutors whose tutees stop attending should be offered support in terms of additional training to enable them to form more supportive relationships with their students. It should also be acknowledged that some students do still need support going into their second year and there should be an option of receiving this from a dedicated tutor who has successfully helped students in the past, especially for those who did not do as well in their first year examinations. As was seen in Chapter 4, the students' examination results were highly correlated year on year so those that were struggling at the end of

their first year continued to do so through until the end of their degree, if indeed they completed it.

More use could also be made of a virtual learning environment to encourage students to post questions and discuss their work online. This would enable them to see that others are having similar difficulties from early on and allow the lecturer to give feedback for them all to see. This happens on some modules already but if a more coordinated approach was adopted and its use rolled out across all the first year modules initially, in a unified and integrated way, then if successful it could be carried on into the second and third year modules.

Some staff also already make themselves available to students through designated "office hours", when students know they are in their office and available to answer questions. However, with a first year cohort of approximately 200 students staff do need to think of new innovative ways of supporting them. Again, a more coordinated and consistent approach across all the first year modules could help students to feel supported from the outset. Some of these office hours could also be used to reach a wider group of students instead of one to one help, by asking students to post their questions in advance, and then giving online help that all the students can access at that time, or return to later as an archive. This might also help to initiate online discussion amongst the students.

Further research

Having gained greater insight into these students' experiences I feel it would be interesting to follow this study up both with further investigations of a similar nature, and to use what has been found within this study to improve experiences of future groups of students.

On a large scale, studies that tracked students in different mathematics departments over time could further work on student trajectories and suggest factors that are helpful in providing more targeted support for students at key times. With this larger sample of students it would therefore be interesting to see how students stuck in the transition stage of the rites of passage could be helped to move on to the

incorporation stage, as well as investigating whether other pathways through the rites of passage are experienced by students.

In terms of improving undergraduates' experiences within this department, I would suggest that small scale intervention studies could be used to investigate whether some of the practical implications of this, and other studies, have an impact. For example an overhaul of the tutorial system to ensure that all staff are aware of best practice could be undertaken. This could be instigated through a departmental training day initially, then tutors taking part in peer observation over the year, and followed up by another training day to enable staff to reflect on their experiences.

Finally, as a follow up to this study, it would be interesting to contact all the students who were interviewed and undertake a further investigation into their current attitudes to mathematics. This could include asking for their reflections back to before and directly after their degree course, what they now feel were the main influences on them during their time at university, and how much the feel their course has helped them in their current career. Aside from this, on a purely personal level it would also be very interesting to see what paths their lives have taken since we last met, and how much they have changed.

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UNIVERSITY XXX

Students' prior experiences of mathematics

Confidential Student Questionnaire

Congratulations on being offered a place to study mathematics at University XXX.

This questionnaire is the first data gathering exercise in a research study that hopes to follow your progress throughout your time at XXX. We are interested both in your views of studying mathematics, as well as your experience of university life in general. The information you provide for this research will not be divulged to any other party, but overall results will feedback to the mathematics department. Therefore do not worry about projecting a good image; your answers will remain confidential.

If you have any questions, please do not hesitate to contact me:
Judith MacBean, Research Fellow
xxx

On the following pages please indicate your response to each of the items by either ticking (☑) the appropriate box, or by writing your answer in the space provided. The whole questionnaire should only take about 15 minutes to complete.

Thank you in advance for your help.

Students' prior experience of mathematics questionnaire

1. Sex Male ❑ Female ❑

2. Age group 18-20 ❑ 21-25 ❑ 26 and over ❑

The following set of questions is about your previous study of mathematics at school or college.

3. What qualifications do you already hold in mathematics, and what grades did you obtain?

	GCSE	Access	"A" level	Further Maths	"S" level etc	Other (please specify) .....
	❑	❑	❑	❑	❑	❑
Grade Obtained	.....	.....	.....	.....	.....	.....

4. Where applicable, what modules did you take in these examinations?

Exam level:.....	Exam level:	Exam level: .....
Modules:	Modules:	Modules:
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

5. Do you feel these examination results are a good reflection of your current mathematical ability? Yes ❑ No ❑

6. If not, why not?

.....

.....

.....

7. What do you find enjoyable about mathematics?

(i) .....

(ii) .....

(iii) .....

8. What do you not like about mathematics?

(i) .....

(ii) .....

(iii) .....

If you did not study GCSE or A-level mathematics please answer the following questions with your own examination system in mind.

9. How were you taught mathematics at GSCE-level (age 14-16 equivalent)? If you had different types of lesson, or several teachers with differing teaching styles please indicate this.

.....

.....

.....

10. Do you feel that the way in which you were taught influenced your subsequent choice of studying mathematics at A-level? Yes ❑ No ❑

11. If so, how?

.....

12. How were you taught mathematics at A-level (age 16-18 equivalent)? If you had different types of lesson, or several teachers with differing teaching styles please indicate this.

.....

.....

.....

13. Do you feel that the way in which you were taught influenced your subsequent choice of studying mathematics at degree level? Yes ❑ No ❑

14. If so, how?

.....

15. Did you ever receive support/help for your learning of mathematics from anyone other than a teacher? Yes ❑ No ❑

16. If yes, from whom?

.....

17. Who (e.g. teachers, relatives, friends) do you feel has most influenced your enjoyment of mathematics, and why?

.....

.....

.....

The following set of questions is about your choice of going on to studying in higher education.

18. What were your main reasons for choosing to go to university?

.....

.....

19. Please indicate how important each of the following statements was for you in choosing to apply to university.

	A lot	**A little**	**Not at all**
It was expected of me	❑	❑	❑
I don't want to get a job yet	❑	❑	❑
I need a degree for my future career	❑	❑	❑
I want to get away from home	❑	❑	❑
I want to continue studying	❑	❑	❑
I'm hoping for a good social life	❑	❑	❑
I couldn't think what else to do	❑	❑	❑
Other (please specify)	❑	❑	❑

20. Have you taken a "gap" year before going to university? Yes ❑ No ❑

21. If so, what have you done during the year?

.....

22. What are you *most* looking forward to about going to university?

.....

23. What are you *least* looking forward to about going to university?

.....

24. How do you think studying at university will differ from studying at school / college?

.....

The next set of questions is more specifically about your choice of studying mathematics at University XXX).

25. What was your main reason for choosing to study mathematics?

.....

26. Please indicate how important the following statements were for you when choosing to study mathematics at degree level.

	A lot	A little	Not at all
I've always been interested in maths	❑	❑	❑
I've always enjoyed maths	❑	❑	❑
Maths is my best academic subject	❑	❑	❑
I need maths for my chosen career	❑	❑	❑
Maths is useful for lots of careers	❑	❑	❑
A maths degree will get me a well paid job	❑	❑	❑
My family thought I should do a maths degree	❑	❑	❑
Some of my friends are doing a maths degree	❑	❑	❑
My teachers thought I should do a maths degree	❑	❑	❑
It is a difficult subject and I like a challenge	❑	❑	❑
I couldn't think of anything else to study	❑	❑	❑

27. Was XXX your first choice of university? Yes ❑ No ❑

28. If so, why did you choose XXX?

.....

29 If not,

a. which university and degree course was your first choice, and why?

.....

b. by what route did you end up at XXX? E.g. clearing, transfer etc.

.....

30. What is the title of the degree course you will be following at XXX?

.....

31. How is this degree classified?

Mathematics single honours	Mathematics joint honours	Mathematics with another subject	Other
❑	❑	❑	❑

32. If you are studying a joint honours degree, which of the two subjects do you think you will end up enjoying most, and why?

.....

.....

.....

33. If you were forced to, which of the two subjects would you choose to study as a single honours degree, and why?

.....

.....

.....

The next set of questions is about your finances and living arrangements while studying for your degree

34. Do the financial aspects of going to university worry you?

A lot ❑ A little ❑ Not at all ❑

35. If you have decided to live with your parents during your time at university, is this for financial reasons?

Yes ❑ No ❑ Not living at home ❑

36. If you will not be living with your parents, do you know where you will be living during your first year of study?

University hall of residence ❑
University flat/house share ❑
With other family ❑
With friends / partner in rented accommodation ❑
In my own property ❑
Don't yet know ❑
Other (please specify) ❑
.....

37. Have you ever lived away from your parental home before for any length of time?

Yes ❑ No ❑ Living at home ❑

38. If yes, please explain the circumstances.

.....

39. If you will be living away from home, how well equipped do you feel you are to look after yourself in terms of your finances and domestic management?

Very ❑ A bit ❑ Not at all ❑

40. What proportion of your fees and maintenance/living expenses will be contributed to by the following sources?

	None	A bit	About half	Most	All
Work in holidays	❑	❑	❑	❑	❑
Work in term time	❑	❑	❑	❑	❑
Parents	❑	❑	❑	❑	❑
Other family	❑	❑	❑	❑	❑
Own savings	❑	❑	❑	❑	❑
Loans	❑	❑	❑	❑	❑
Other (please specify)	❑	❑	❑	❑	❑

41. Are you thinking of having a term time job during your first year at university?

Yes ❑ No ❑ Not sure ❑

The next set of questions is about your possible future career

42. Do you have any idea as to the sort of career that you would like to have when you have finished your degree?

Yes ❑ No ❑ Not sure ❑

43. If yes, what type of career are you thinking of?

.....

44. Might you consider further study when you have finished your degree?

Yes ❑ No ❑ Not sure ❑

45. If yes, what are you thinking of studying?

.....

46. Have you considered a career in teaching maths?

Yes ❑ No ❑ Not sure ❑

47. Please explain your reasons?

.....

The final questions look ahead to when you start your degree course at XXX

	Yes	No
48. Would you be willing to be interviewed individually about how you are experiencing your degree course and university life in general?	❑	❑

	Yes	No
49. Would you be willing to take part in a small group interview about how you are experiencing your degree course and university life in general?	❑	❑

Contact details:
Term time address (if known)

.....

.....

.....

Term time telephone number (if known)

.....

Mobile phone number

.....

Thank you for taking the time to complete this questionnaire. We look forward to meeting and working with you when you start your degree at XXX.

If you have any other relevant information regarding your prior experience of learning mathematics please feel free to write below or on the back of this sheet.

Approaches to studying and conceptions of mathematics questionnaire

Please read and complete the following before starting the main body of the questionnaire.

Full name: **Degree course title:**

Please respond to each of the following items by indicating with a tick (☑) the extent to which you agree with the statement. Do not spend a long time thinking about your response; your first reaction is probably the most reliable. Do not worry about projecting a good image; all of the information you provide is purely for research purposes and individuals' responses will not be divulged to your department.

Judith MacBean, Research Fellow
Department of Education and Professional Development
University XXX

Statements relating to your study of mathematics

		Strongly Agree		Neutral / Don't know		Strongly Disagree
1	I try to relate ideas in one area of mathematics with those in others, wherever possible	❑	❑	❑	❑	❑
2	I usually set out to understand thoroughly the meaning of the mathematics topic being covered	❑	❑	❑	❑	❑
3	The continual pressure of work – assignments, deadlines, and competition – often makes me tense and depressed	❑	❑	❑	❑	❑
4	I find it difficult to 'switch tracks' when working on a maths problem: I prefer to follow each line of thought as far as it will go	❑	❑	❑	❑	❑
5	Lecturers seem to delight in making simple mathematical concepts unnecessarily complicated	❑	❑	❑	❑	❑
6	I generally put a lot of effort into trying to understand things which initially seem difficult	❑	❑	❑	❑	❑

7	I learn mathematics best from lecturers who work from carefully prepared notes and outline the major points clearly for me.	❑	❑	❑	❑	❑
8	I become increasingly absorbed in mathematics the more I do	❑	❑	❑	❑	❑
9	When I am reading I try to memorise important facts which may come in useful later	❑	❑	❑	❑	❑
10	In studying mathematics I focus more on the examples than the theoretical material.	❑	❑	❑	❑	❑
11	I concentrate on studying mathematics largely with a view to the job situation in the future rather than because of how much it interests me.	❑	❑	❑	❑	❑
12	I find that studying mathematics gives me a feeling of deep personal satisfaction.	❑	❑	❑	❑	❑
13	I only study seriously the mathematics that is covered in lectures.	❑	❑	❑	❑	❑
14	While I'm studying mathematics I think of real life situations in which the material that I am learning would be useful.	❑	❑	❑	❑	❑
15	I learn some things in mathematics by rote, going over and over them until I know them by heart.	❑	❑	❑	❑	❑
16	I feel that mathematics becomes interesting once I become involved in studying it.	❑	❑	❑	❑	❑
17	Although I generally remember facts and details, I find it difficult to put them together in an overall picture	❑	❑	❑	❑	❑
18	I worry that even if I work hard in mathematics the assessment might not reflect this.	❑	❑	❑	❑	❑
19	I restrict my study of mathematics to what is specifically set, as I think it is unnecessary to do anything extra.	❑	❑	❑	❑	❑
20	I try to relate what I have learnt in mathematics to material in other subjects.	❑	❑	❑	❑	❑
21	A poor first answer in an exam makes me panic	❑	❑	❑	❑	❑
22	I find most aspects of mathematics interesting and spend extra time trying to obtain more information about them.	❑	❑	❑	❑	❑
23	I accept the mathematical statements and ideas of my lecturers and rarely think to question them.	❑	❑	❑	❑	❑
24	My aim in studying mathematics is to understand it for my own satisfaction.	❑	❑	❑	❑	❑
25	I am prepared to work hard in mathematics because I feel it will contribute to my employment prospects.	❑	❑	❑	❑	❑
26	Studying mathematics challenges my views on how the world works.	❑	❑	❑	❑	❑

Questionnaire B - Appendix II

Statements about your overall conceptions of mathematics

		Strongly Agree		Neutral / Don't know		Strongly Disagree
1	For me, mathematics is the study of numbers	❑	❑	❑	❑	❑
2	Mathematics is a lot of rules and equations.	❑	❑	❑	❑	❑
3	By using mathematics we can generate new knowledge.	❑	❑	❑	❑	❑
4	Mathematics is simply an over complication of addition and subtraction	❑	❑	❑	❑	❑
5	Mathematics is about calculations.	❑	❑	❑	❑	❑
6	Mathematics is a set of logical systems which have been developed to explain the world and relationships in it	❑	❑	❑	❑	❑
7	What mathematics is about is finding answers through the use of numbers and formulae	❑	❑	❑	❑	❑
8	I think mathematics provides an insight into the complexities of our reality	❑	❑	❑	❑	❑
9	Mathematics is figuring out problems involving numbers.	❑	❑	❑	❑	❑
10	Mathematics is a theoretical framework describing reality with the aim of helping us understand the world.	❑	❑	❑	❑	❑
11	Mathematics is like a universal language that allows people to communicate and understand the universe.	❑	❑	❑	❑	❑
12	The subject of mathematics deals with numbers, figures and formulae.	❑	❑	❑	❑	❑
13	Mathematics is about playing around with numbers and working out numerical problems.	❑	❑	❑	❑	❑
14	Mathematics uses logical structures to solve and explain real life problems	❑	❑	❑	❑	❑
15	What mathematics is about is formulae and applying them to everyday life and situations.	❑	❑	❑	❑	❑
16	Mathematics is a subject where you manipulate numbers to solve problems	❑	❑	❑	❑	❑
17	Mathematics is a logical system that helps explain the things around us.	❑	❑	❑	❑	❑
18	Mathematics is the study of the number system and solving numerical problems.	❑	❑	❑	❑	❑
19	Mathematics is models that have been devised over years to help explain, answer and investigate matters in the world	❑	❑	❑	❑	❑

Thank you for taking the time to complete this questionnaire. If you have any other comments you would like to make, please do so on the back of this sheet.

Questionnaire C - Appendix III

UNIVERSITY XXX

Students' Experiences of Undergraduate Mathematics

Confidential Student Questionnaire
Second Year

Questionnaire C - Appendix III

Thank you for all your help with our research project so far.

We take your responses very seriously and are grateful to you for taking the time to complete our questionnaires fully. Staff in the maths department are also very interested in your views as they are always looking at ways to improve the delivery of the various programmes.

As you know, we are particularly interested in getting your views about your maths courses but we are also interested in learning about how you experience university life in general.

This questionnaire is designed to compare and contrast your first and second year experiences. As before, please be assured that your individual responses will not be seen by anyone in the maths department, nor will they be used in any form of assessment.

If you have any questions, please contact:
Judith MacBean
Research Fellow
XXX

Thank you again for your help.

This questionnaire should take you no longer than 10 minutes to complete. Please respond to each of the items on the following pages by indicating your answer with a tick (✓) in the appropriate box, or by writing your response on the line(s) provided.

Questionnaire C - Appendix III

In the first set of questions, we ask you to reflect back on your experiences during the *first* year of your mathematics course.

1. **How much did you enjoy the maths you studied in your first year?**

   A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

2. **What did you enjoy *most* about the maths in your first year?**

   _____

   _____

3. **What did you enjoy *least* about the maths in your first year?**

   _____

   _____

4. **In what ways could your first year maths course have been improved?**

   _____

   _____

5. **How different was the course from what you expected?**

   A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

6. **What were the biggest differences you experienced?**

   _____

   _____

7. **Did you find the amount of work you had to do in first year**

   Very heavy ❑ Quite heavy ❑
   Not very heavy ❑ Quite light ❑

8. **You will have found parts of your first year course harder than others but, on average, was the course**

   Much harder than you expected ❑
   A bit harder than you expected ❑
   About what you expected ❑
   A bit easier than you expected ❑

9. What aspects of the first year course did you find particularly difficult?

_____

_____

10. What was the most interesting new maths you learned in first year?

_____

_____

11. How satisfied were you with the tutorial classes?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please explain your answer.

_____

_____

12. What did you think of your first year exam results?

Much better than I expected ❑ A bit better than I expected ❑
About what I expected ❑ A bit worse than I expected ❑
Much worse than I expected ❑

13. Did you think you achieved the best results you were capable of?

Yes ❑ No ❑

14. If no, why do you think that was?

A-levels were poor preparation for the course ❑
Standard of lecturing was poor ❑
Other academic support was poor ❑
I didn't work hard enough ❑
Other (please specify) ❑

_____

15. If you did not work hard enough, why was this?

Too much time spent on social activities ❑
Peer pressure from my friends ❑
Had a part-time job ❑
Not motivated by the course content ❑
A lot of the course was too hard for me ❑
Poor health ❑
Other (please specify) ❑

_____

16. What were the main differences between school and university maths?

_____

_____

The next set of questions is about your *second* year mathematics course.

17. How much have you enjoyed the maths you studyied in second year?

A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

Please explain your answer.

_____

_____

18. How different was second year maths from first year?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

What are the main differences?

_____

_____

19. How satisfied were you with the choices you made of second year modules?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please explain your answer.

_____

20. What criteria did you use when deciding which modules to choose?

_____

_____

21. What aspects of the second year course have you found particularly difficult?

_____

_____

22. What is the most interesting new maths you have learned in second year?

_____

_____

23. How much did you miss not having regular tutorials this year?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please explain your answer.

_____

24. How often do you go to your academic tutor for help with your work?

About once a week ❑ A few times a term ❑
Once or twice a year ❑ Have never gone ❑

Please explain your answer.

_____

_____

25. Do you find the amount of work you have to do

Very heavy ❑ Quite heavy ❑
Not very heavy ❑ Quite light ❑

26. You will have found parts of your second year course harder than others but, on average, was the second year course

Much harder than you expected ❑
A bit harder than you expected ❑
About what you expected ❑
A bit easier than you expected ❑

27. How did the course workload compare with first year?

Much harder ❑ A bit harder ❑
About the same ❑ A bit easier ❑

Please explain your answer.

_____

_____

28. Have you, at this stage, any plans for a career when you finish your maths degree?

Yes ❑ No ❑

If yes, what sorts of things are you thinking of doing?

_____

29. How useful do you think the maths you are studying at university will be in any career you follow?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please give reasons for your answer.

_____

_____

30. How much do you feel you belong to a 'community' of maths students and lecturers at University X?

A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

31. What could be done to promote a sense of belonging to a maths community?

_____

_____

32. How pleased are you that you chose to study maths at university?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please give reasons for your answer.

_____

The next set of questions is about your *first* year experiences of university.

33. How was your health in your first year?

Very good ❑ Quite good ❑
Not very good ❑ Quite bad ❑

34. How happy were you with your social life during your first year?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please explain your answer.

_____

_____

35. Were you a member of any clubs or did you take part in any activities (e. g. sports, music, drama, religious, political, debating society, voluntary work etc.) last year?

Yes ❑ No ❑

If yes, please specify.

_____

_____

36. Where did you find it most easy to make friends during your first year?

On maths course ❑ In halls ❑
In university clubs ❑ Other (please specify) ❑

_____

37. Did you have one or more part-time jobs during *term time* in first year?

Yes ❑ No ❑

If yes, what did you do and on average how many hours a week did you work?

_____

38. Did you have one or more jobs during the *holidays* in first year?

Christmas holiday	Yes	❑	No	❑
Easter holiday	Yes	❑	No	❑
Summer holiday	Yes	❑	No	❑

If yes, what did you do and on average how many hours a week did you work?

_____

_____

_____

39. Overall, how much of a worry was money to you in first year?

A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

40. By the end of first year, approximately how much were you in debt?

_____

The next set of questions is about your *second* year experiences of university.

41. Where are you living during your second year at university?

Flat/house share	❑
With parents/step parents	❑
Other (please specify)	❑

_____

42. How satisfied are you with your accommodation?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please explain your answer

_____

_____

43. If in a flat/house share, what courses are the others on?

_____

_____

_____

44. How well do you get on with your flat/house mates?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

45. What issues provoke most disagreements with flat/house mates?

_____

_____

46. How has your health been during your second year?

Very good ❑ Quite good ❑
Not very good ❑ Quite bad ❑

47. How happy are you with your social life in second year?

Very ❑ Quite ❑ Not very ❑ Not at all ❑

48. In what ways is it different from first year?

_____

_____

49. Are you a member of any clubs or do you take part in any activities (e. g. sports, music, drama, religious, political, debating society, voluntary work etc.) this year?

Yes ❑ No ❑

If yes, please specify.

_____

_____

50. **Have you had a part-time job during *term time* in your second year?**

Yes ❑ No ❑

If yes, what have you been doing and on average how many hours a week have you been working?

_____

_____

51. **Did you have a job over the Christmas holiday in second year?**

Yes ❑ No ❑

If yes, what were you doing and on average how many hours a week did you work?

_____

_____

52. **Overall, how much of a worry is money to you this year?**

A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

53. **How much do you feel you belong to a community of students at University X?**

A lot ❑ Quite a lot ❑ Not much ❑ Not at all ❑

54. **What more could be done to promote a sense of belonging to a student community?**

_____

_____

55. **How satisfied are you with your choice of University X?**

Very ❑ Quite ❑ Not very ❑ Not at all ❑

Please explain your answer.

_____

Questionnaire C - Appendix III

Please fill in your name below to allow us track your experiences during your time at University X. This page will be removed later, and your individual responses will not be divulged to anyone in the maths department.

Name:

Degree Course:

We are trying to talk to as many of you as possible in order to collect a wide range of views about being a maths student at University X. If we haven't managed to talk to you yet and you would like to have a chat, please give your mobile number and / or email address below.

Mobile:

Email:

If you think of anything else at a later date, you can always raise it at any time by sending an email to:

THANK YOU FOR YOUR PATIENCE AND TIME.
WE HOPE YOU ARE ENJOYING YOUR TIME AT UNIVERSITY X.
WE LOOK FORWARD TO CONTINUING TO WORK WITH YOU THROUGHOUT THE REST OF YOUR MATHS DEGREE.

Questionnaire D - Appendix IV

UNIVERSITY XXX

Students' Experiences of Undergraduate Mathematics

Confidential Student Questionnaire
Third Year

Thank you for all your help with our research project so far. You will no doubt be pleased to know that this is the last questionnaire that we will be asking you to fill in.

We take your responses very seriously and are grateful to you for taking the time to complete our questionnaires fully. Staff in the maths department are also very interested in your views as they are always looking at ways to improve the delivery of the various programmes.

As you know, we are particularly interested in getting your views about your maths courses but we are also interested in learning about how you experience university life in general.

This questionnaire is designed to find out what you have thought overall of your three years at University XXX, and to provide us with a comparison to your first year experience. As before, please be assured that your individual responses will not be seen by anyone in the maths department, nor will they be used in any form of assessment.

If you have any questions, please do not hesitate to contact me:

Judith MacBean
Research Fellow
XXX

Thanks again for your help.

Please complete all of the following

Your name: .....

The title of your course: .....
(e.g. Maths and Physics BSc)

Your Three Years At University XXX

What have you enjoyed most about your degree course?

.....
.....
.....
.....
.....

What have you enjoyed least about your degree course?

.....
.....
.....
.....

How much do you enjoy maths now compared to at the end of your A levels?

More now ❑ **Less now** ❑ **The same** ❑

Why?

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.....

In what ways has your view of what maths is changed over the last three years?

.....
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.....

This final part of the questionnaire should only take you about 10 minutes to complete. Please respond to each of the items on the following pages by indicating your answer with a tick (✓) in the appropriate box, or by writing your response on the line(s) provided.

Statements relating to your study of mathematics

		Strongly Agree		Neutral / Don't know		Strongly Disagree
1	I try to relate ideas in one area of mathematics with those in others, wherever possible	❑	❑	❑	❑	❑
2	I usually set out to understand thoroughly the meaning of the mathematics topic being covered	❑	❑	❑	❑	❑
3	The continual pressure of work – assignments, deadlines, and competition – often makes me tense and depressed	❑	❑	❑	❑	❑
4	I find it difficult to 'switch tracks' when working on a maths problem: I prefer to follow each line of thought as far as it will go	❑	❑	❑	❑	❑
5	Lecturers seem to delight in making simple mathematical concepts unnecessarily complicated	❑	❑	❑	❑	❑
6	I generally put a lot of effort into trying to understand things which initially seem difficult	❑	❑	❑	❑	❑
7	I learn mathematics best from lecturers who work from carefully prepared notes and outline the major points clearly for me.	❑	❑	❑	❑	❑
8	I become increasingly absorbed in mathematics the more I do	❑	❑	❑	❑	❑
9	When I am reading I try to memorise important facts which may come in useful later	❑	❑	❑	❑	❑
10	In studying mathematics I focus more on the examples than the theoretical material.	❑	❑	❑	❑	❑
11	I concentrate on studying mathematics largely with a view to the job situation in the future rather than because of how much it interests me.	❑	❑	❑	❑	❑
12	I find that studying mathematics gives me a feeling of deep personal satisfaction.	❑	❑	❑	❑	❑
13	I only study seriously the mathematics that is covered in lectures.	❑	❑	❑	❑	❑
14	While I'm studying mathematics I think of real life situations in which the material that I am learning would be useful.	❑	❑	❑	❑	❑
15	I learn some things in mathematics by rote, going over and over them until I know them by heart.	❑	❑	❑	❑	❑
16	I feel that mathematics becomes interesting once I become involved in studying it.	❑	❑	❑	❑	❑

	Strongly Agree		Neutral / Don't know		Strongly Disagree
17 Although I generally remember facts and details, I find it difficult to put them together in an overall picture	❑	❑	❑	❑	❑
18 I worry that even if I work hard in mathematics the assessment might not reflect this.	❑	❑	❑	❑	❑
19 I restrict my study of mathematics to what is specifically set, as I think it is unnecessary to do anything extra.	❑	❑	❑	❑	❑
20 I try to relate what I have learnt in mathematics to material in other subjects.	❑	❑	❑	❑	❑
21 A poor first answer in an exam makes me panic	❑	❑	❑	❑	❑
22 I find most aspects of mathematics interesting and spend extra time trying to obtain more information about them.	❑	❑	❑	❑	❑
23 I accept the mathematical statements and ideas of my lecturers and rarely think to question them.	❑	❑	❑	❑	❑
24 My aim in studying mathematics is to understand it for my own satisfaction.	❑	❑	❑	❑	❑
25 I am prepared to work hard in mathematics because I feel it will contribute to my employment prospects.	❑	❑	❑	❑	❑
26 Studying mathematics challenges my views on how the world works.	❑	❑	❑	❑	❑

Statements about your overall conceptions of mathematics

	Strongly Agree		Neutral / Don't know		Strongly Disagree
1 For me, mathematics is the study of numbers	❑	❑	❑	❑	❑
2 Mathematics is a lot of rules and equations.	❑	❑	❑	❑	❑
3 By using mathematics we can generate new knowledge.	❑	❑	❑	❑	❑
4 Mathematics is simply an over complication of addition and subtraction	❑	❑	❑	❑	❑
5 Mathematics is about calculations.	❑	❑	❑	❑	❑
6 Mathematics is a set of logical systems which have been developed to explain the world and relationships in it	❑	❑	❑	❑	❑
7 What mathematics is about is finding answers through the use of numbers and formulae	❑	❑	❑	❑	❑
8 I think mathematics provides an insight into the complexities of our reality	❑	❑	❑	❑	❑
9 Mathematics is figuring out problems involving numbers.	❑	❑	❑	❑	❑

Questionnaire D - Appendix IV

	Strongly Agree		Neutral / Don't know		Strongly Disagree
10 Mathematics is a theoretical framework describing reality with the aim of helping us understand the world.	❑	❑	❑	❑	❑
11 Mathematics is like a universal language that allows people to communicate and understand the universe.	❑	❑	❑	❑	❑
12 The subject of mathematics deals with numbers, figures and formulae.	❑	❑	❑	❑	❑
13 Mathematics is about playing around with numbers and working out numerical problems.	❑	❑	❑	❑	❑
14 Mathematics uses logical structures to solve and explain real life problems	❑	❑	❑	❑	❑
15 What mathematics is about is formulae and applying them to everyday life and situations.	❑	❑	❑	❑	❑
16 Mathematics is a subject where you manipulate numbers to solve problems	❑	❑	❑	❑	❑
17 Mathematics is a logical system that helps explain the things around us.	❑	❑	❑	❑	❑
18 Mathematics is the study of the number system and solving numerical problems.	❑	❑	❑	❑	❑
19 Mathematics is models that have been devised over years to help explain, answer and investigate matters in the world	❑	❑	❑	❑	❑

If you have any other comments you would like to make, please do so below.

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Thank you for taking the time to complete this questionnaire.

Interview Schedules (Rounds 1 – 3) - Appendix V

First Round of Interviews

Could you tell me a bit about yourself? Your background / family / where you went to school etc?

Could you tell me a bit about why you decided to study maths/maths & … as a degree?

- Why single/joint honours, i.e. maths & …?
- Why particularly did you decide on UCL?

Before you came to UCL what were your expectations of life in general at university?

- Have these expectations been confirmed? How/how not?
- What about where are you living? Do you like your accommodation?
- Have you made made friends?

And what were your expectations of studying mathematics at degree level?

- Have these expectations been confirmed?
- How/how not?

So far, which of your courses/modules have you been enjoying the most?

- Why?

Could you describe for me how you were taught mathematics at school? If you have experienced a variety of teaching methods could you briefly describe them all?

Have you seen any differences so far between how you were taught maths at school and how you have been taught maths at university?

- Would you say that you have a preferred way/method of being taught mathematics? Why?

Have you had to adapt the way you study maths since starting at university?

- How?

How do you feel about maths as a subject to learn? Why?

- Is this different from how you felt about maths when you left school?

How do you think you most effectively learn mathematics? For example, what methods do you use say for completing a coursework or revising for an exam?

What do you specifically enjoy about maths that made you chose it over other subjects?

- What do you feel makes maths different from other academic subjects?

How much maths do you do outside of your degree (i.e. lectures and coursework)?

- e.g. do you ever: attend talks and seminars / read books about maths and mathematicians / attempt puzzles or maths problems out of general interest and a sense of enjoyment?

If you had to sum (excuse the pun!) maths up as a subject what key words would you use?

Do you think you will end up using the maths you're learning in your degree when you finally leave UCL? How / why not?

Second Round of Interviews

Mid-year Exams:

- How were the exams?
- Before you received your results, how did you feel you had done?
- Were your results a surprise?
- Was this how you expected to do?
- What effect has this had on your morale?
- What effect has this had on your motivation?

Courses & Dept:

- How have you found the courses this term?
- Are they harder/easier than last terms?
- Are you enjoying the degree more or less than you were last term? Why?
- How are you fitting into the department?
- Do you feel part of a maths community?
- Where do you spend most of your time outside of lectures and tutorials?
- Which dept do you feel most affiliated to, maths or "other subject"? Why?

Social:

- How have your friendships changed?
- Do you spend more time with a particular group?
- If so are they from the maths dept / hall of residence / other?
- Have you had any health problems, and if so how has this effected your work?
- How are you managing financially? Have you had a part-time job?
- How are you finding living away / living at home?
- Have you joined any clubs or societies?
- How are you enjoying living in London?
- Do you go out much, or stick to the university social events?

Third Round of Interviews

It has been almost a year since I last interviewed the students, so there is quite a lot to discuss.

End of first year:

- How did the rest of the spring term go?
- Did your attendance change during the year? Why do you think that was?
- How did you spend your Easter holidays?
- What were your feelings about the exams?

First-year Exams:

- How were the exams?
- Before you received your results, how did you feel you had done?
- Were your results a surprise?
- Was this how you expected to do?
- What effect has this had on your morale?
- What effect has this had on your motivation?

Summer:

- What did you do during your summer break?

Last term (Autumn 2002):

- How have you found the courses this year?
- Are you enjoying the degree more or less than you were last year? Why?
- How are you fitting into the department?
- Do you feel part of a maths community?
- Where do you spend most of your time outside of lectures and tutorials?
- Which dept do you feel most affiliated to, maths or "other subject"? Why?

This term (Spring 2003):

- Do you have optional courses this term? What difference has this made?

Social:

- How have your friendships changed?
- Do you spend more time with a particular group?
- What are your living arrangements this year? What effect has this change had?
- Have you had any health problems, and if so how has this effected your work?
- How are you managing financially? Have you had a part-time job?
- How are you finding living away / living at home?
- Are you continuing with any of the clubs or societies you joined last year?
- How are you enjoying living in London?
- Do you go out more or less than last year? Why do you think that is?

Quotes used for 6th round of interviews - Appendix V

"You know, it's all about when it dawns on you, . . . I love that, I love it when I feel like that, that it's all dawned on me. That's why I really enjoy it, it's because of the fact that the boost you get at the end of it when you've achieved something, it's so nice."

Joint Honours Student – Year 1

"I suppose, one of the aspects is that, most people don't really understand Maths, don't really like that, and when you do understand it, you kind of feel kind of special in a way, you understand it."

Single Honours Student – Year 1

"It's good to feel good at something. A lot of people say 'I do Maths because I'm good at it'".

Combined Honours Student – Year 1

"I think I'm enjoying it a lot more now, because I'm actually starting to understand the work and cope, and I'm working a lot harder. I think last term I was still trying to settle in, it took me a long time to settle in, and that's basically where the problem started."

Joint Honours Student – Year 1

"I still don't feel part of the Maths community. I think it's because most people enjoy Maths and they love Maths and they do it 24/7, whereas I'm just going for the degree, and sometimes I'll read up on my notes and stuff, but I don't find it that enjoyable that I'd want to do it every day."

Joint Honours Student – Year 1

"I think at the beginning, I didn't like it, I found it too difficult, but as I got into it more, I thought it was OK. And I think I'm enjoying it more now."

Joint Honours Student – Year 1

"I don't particularly enjoy it. I think I told you last time, I *was* quite sort of into maths, in terms of enjoying it and doing it. [But] if there's a lot of people in a class, you need to make sure at least half of them have got a good chance of passing, so, kind of, in some ways, it's bringing the level down to one you think most people would be able to handle."

Single Honours Student – Year 2

Quotes used for 6th round of interviews - Appendix V

"This year I had so much fun. The course has been really hard, I was moaning, and I was just like, 'Oh, I want to leave.' The courses were really hard, I had no motivation. But, I mean, in all fairness, I look back now, the courses weren't impossible, once you'd sat down and really got into them. And I did start to enjoy some of them, to a certain degree."

Joint Honours Student – End of Year 2

"I think [I enjoy maths] probably slightly less, just for the reason because I've been doing it for so long it seems to drag on now. And now I can really understand why universities want you to be really enthusiastic about a subject, because once you get to uni, after a couple of years, you just get fed up of it."

Joint Honours Student – Year 2

"I just do it, I just don't enjoy it, I just do it. I wouldn't say I go into a lecture and I really find it interesting. I just can do it."

Joint Honours Student – Year 2

"I don't think I ever got enthusiastic, even at school, I think I just did it because I could do it. And some stuff I did find quite interesting, but it's like when you have to keep memorising all these things, it just takes the enjoyment out of it."

Joint Honours Student – Year 2

"Yeah, at A Level I really loved it but since I've been here, it's like they've taken something I love and crushed it and now I hate it and I never want to use it again."

Single Honours Student – Year 3

"At the end of the first year I'd say I was just getting the job done but now, after the second, I'm really enjoying it. I never thought I was interested in maths, the only reason I picked it was that I could do it."

Joint Honours Student – Year 3

"It's like, at A level, because we've done the same things for, like, two years, you get bored of it, and now, maths, there's always something new that comes across. And, also, we're starting to apply maths more to real life situations, which we didn't really do much of in A level. So like you can actually see where it would happen."

Joint Honours Student – Year 3

"I mean, if you asked me this last year, I would have said, 'Oh, I don't recommend anyone to do maths,' but now I would definitely recommend it, it's definitely the type of course that can really sort of open your eyes."

Joint Honours Student – Year 3

Scatter plots of variables used in Questionnaires B and D - Appendix VII

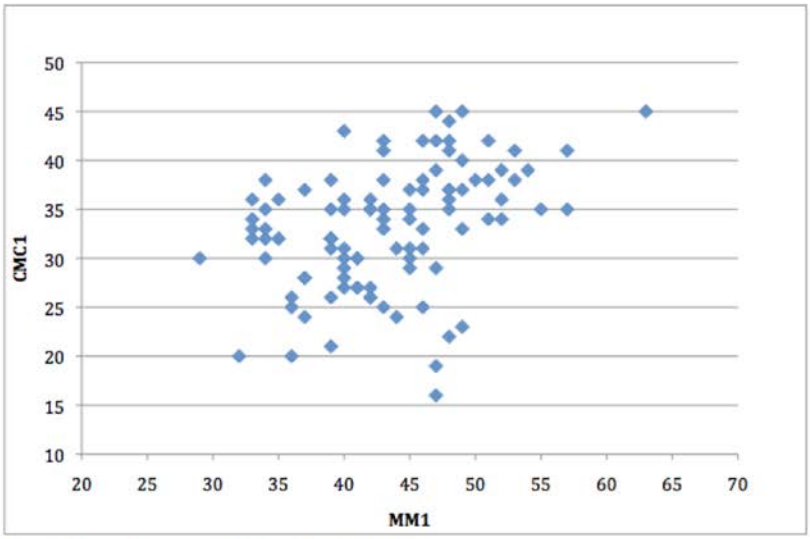

Figure VII.1: Scatter plot of MM1 v CMC1 (N=102)

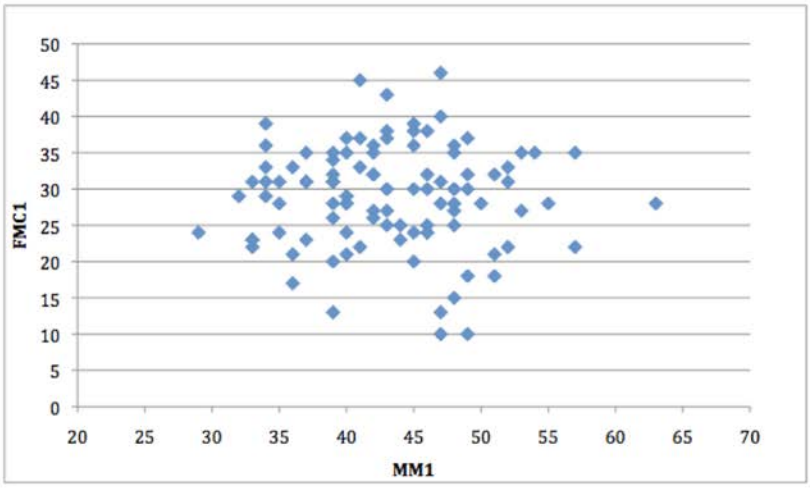

Figure VII.2: Scatter plot of MM1 v FMC1 (N=102)

Scatter plots of variables used in Questionnaires B and D - Appendix VII

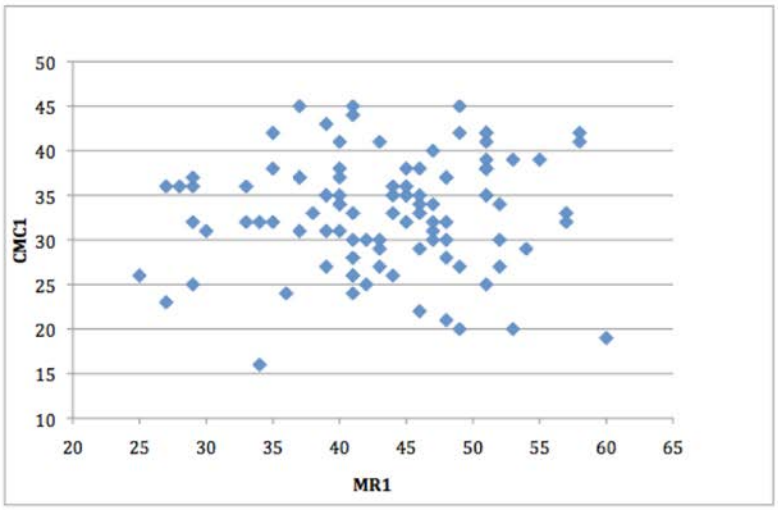

Figure VII.3: Scatter plot of MR1 v CMC1 (N=102)

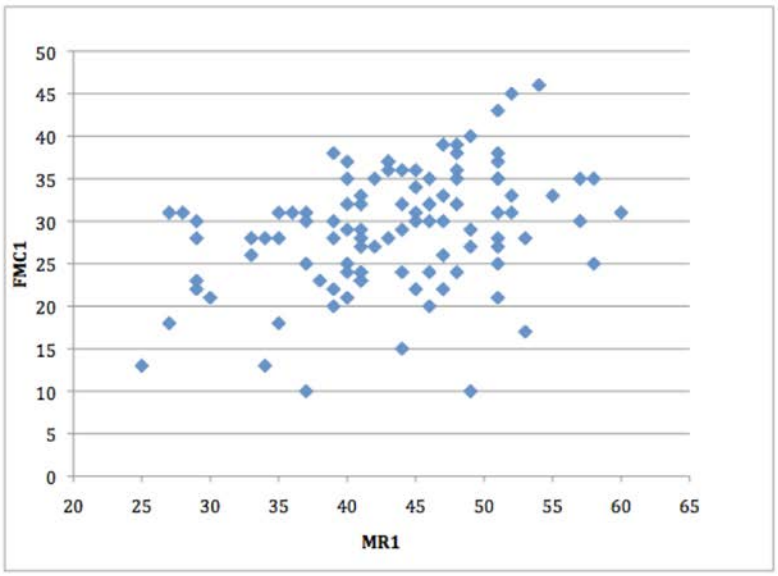

Figure VII.4: Scatter plot of MR1 v FMC1 (N=102)

Scatter plots of variables used in Questionnaires B and D - Appendix VII

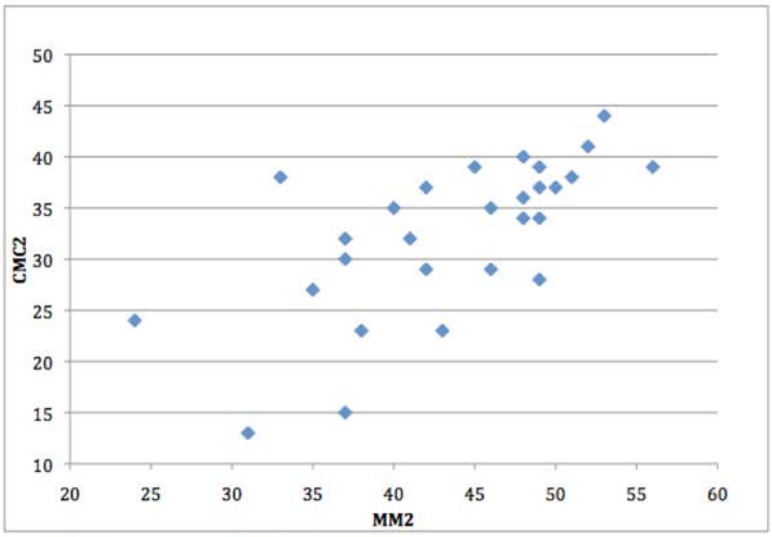

Figure VII.5: Scatter plot of MM2 v CMC2 (N=29)

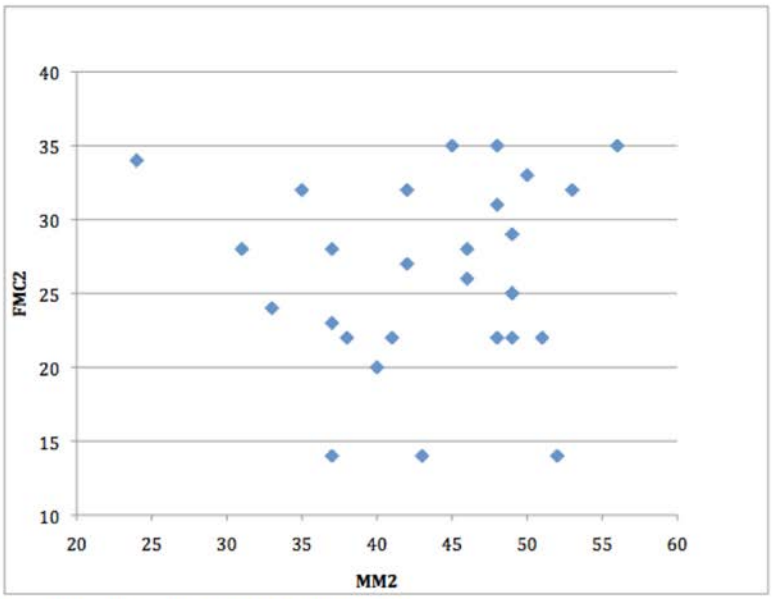

Figure VII.6: Scatter plot of MM2 v FMC2 (N=29)

Scatter plots of variables used in Questionnaires B and D - Appendix VII

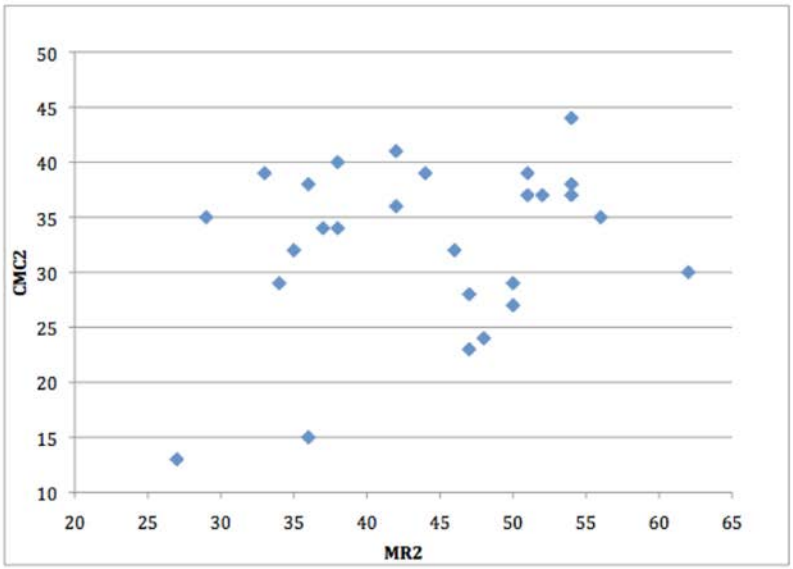

Figure VII.7: Scatter plot of MR2 v CMC2 (N=29)

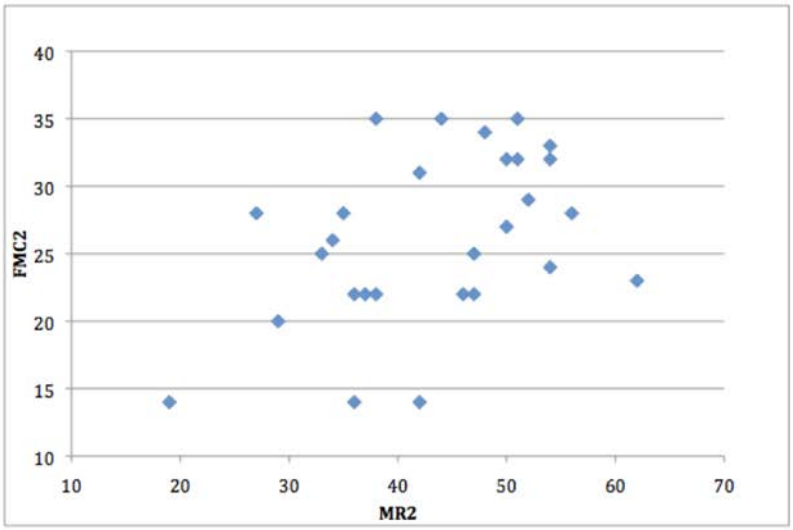

Figure VII.8: Scatter plot of MR2 v FMC2 (N=29)